PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XIX

SAN FRANCISCO
PUBLISHED BY THE ACADEMY
1930–1931

COMMITTEE ON PUBLICATION

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OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XIX, No. 1, pp 1-6 JUNE 4, 1930

I

MARINE MOLLUSCA OF GUADALUPE ISLAND, MEXICO[1]

BY

A M STRONG

AND

G D. HANNA

While weathering a storm in the shelter of Guadalupe Island on April 20, 1925, the members of the expedition of the California Academy of Sciences to the Revillagigedo Islands made such use of their time as the conditions would permit Among other activities some dredging was done in the semi-sheltered cove at the south end of the island The work was done chiefly by G D Hanna, E K Jordan, and J. R. Slevin[2] After some search a small patch of sandy bottom was located and by dragging back and forth across this area several times, a fair sample was secured As might be

[1]EDITOR'S NOTE. Since 1921 the California Academy of Sciences has sent three expeditions to various west Mexican localities, and a considerable number of reports has been issued and numbered serially under each The three series have the following headings Expedition to the Gulf of California in 1921, Expedition to Guadalupe Island in 1922, and Expedition to the Revillagigedo Islands in 1925 Since it is impossible to foresee when the final papers may be expected from these expeditions, it has been decided to discontinue the use of the headings and serial numbers. As succeeding papers are received they will be issued in the regular publications of the Academy, with sufficient explanation, however, to indicate which of the expeditions concerned contributed the material upon which the work is based. In accordance with this plan the present contribution is a direct result of the Expedition to the Revillagigedo Islands in 1925, although a minor amount of data from the Expedition to Guadalupe Island in 1922 is incorporated.—Barton Warren Evermann, *Editor*

[2]See Hanna, Proc. Calif Acad. Sci., ser 4, vol. 15, no. 1, pp 1-113, pls. 1-10, 7 text figs., March 30, 1926, for a general account of the expedition.

expected on such bold shores, much of the sample consisted of volcanic sand and pebbles, worn fragments of shells and other detritus. However, there was a considerable number of species of mollusca, either living or excellently preserved. These are enumerated in the present list which is believed to be justified by the meager knowledge we have heretofore possessed as to the marine life of this remarkable island In addition, we have included a few other species collected on the shores of the island in 1922 and 1925.

Much has been written about Guadalupe, particularly in relation to the vertebrate fauna and the flora [3] The island is surrounded by water approximately 2000 fathoms in depth and is entirely volcanic, although no activity has been recorded in modern times. The surface indicates that the present form is geologically not very old Nevertheless, many of the birds, insects, land shells and plants have been isolated so long that they have become specifically differentiated from their nearest congeners They form a typical waif fauna and flora No definite evidence has been brought forward to indicate that the island has ever been connected, or nearly connected, to the mainland It is situated about 180 miles south-southwest of San Diego, California

Not much is known of the marine life of Guadalupe other than the seals, sea lions and sea elephants There are scattered references to the fishes and crustaceans in the literature, and probably the same is true of the algæ.

The known mollusca of the island, as represented by the Academy's collection, consists of 87 species, of which nine appear to be undescribed and 24 were previously known only from a few localities in southern California or the northern portion of the coast of Lower California. Twenty-four species show a considerable extension of the known ranges, 22 not having previously been reported south of San Diego or the Coronado Islands, and two not having previously been

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[3] For references to the principal literature, see Hanna, Proc Calif Acad Sci., ser 4, vol. 14, no. 2, pp. 217-275, pls 15-19, 2 text figs., September 5, 1925 An account of the land shells has been published by H A Pilsbry, op. cit., vol. 16, no 7, pp 159-203, pls. 6-12, 3 text figs., April 22, 1927

reported north of the Gulf of California Sixteen of the species are known to have a wide range extending from Monterey or further north to the Gulf of California or further south Of the 40 species known to reach as far north as Monterey only 16 are reported from the Gulf of California, while of the 23 species which include the Gulf of California in their known range, 20 are known to reach as far north as Catalina Island and 10 as far north as Puget Sound The fauna, as represented by the collection, is very similar to that of Catàlina Island and the Coronado Islands since all but four of the known species have been reported from those localities

The species in the collection are almost entirely shore or shallow water forms which either live on marine algæ or on or among the rocks to which kelp is attached Floating masses of kelp are always present along the southern California coast and the presence of most of the species on the shores of Guadalupe Island can be accounted for most satisfactorily by the supposition that the spawn or fry has been transported by this means This indicates a current at some time running southerly along the southern California coast and turning out to sea at an angle which carried it past Guadalupe Island The almost complete absence of species which are characteristic of the Gulf of California or the coast of the southern portion of Lower California, indicates that there has been no similar current from the south since the time when the shores of Guadalupe Island were first able to support marine life. It is well recognized that the fauna of the coast of southern California and the neighborhood islands, containing over 1000 species, is distinctly southern in its affiliations with many species at the extreme northern end of their geographic range This fact, taken in connection with the indicated current drift to the south, offers some proof that the prevailing ocean currents and climatic conditions along the southern California coast have changed but little during recent geological times.

LIST OF SPECIES FOUND ON GUADALUPE ISLAND

1. *Acmaea digitalis* Escholtz, Alaska to San Digo.
2 *Acmaea paleacea* Carpenter, Trinidad to Lower California.
3. *Acmaea persona* Escholtz, Aleutians to Soccoro Island
4. *Acteocina angustior* Baker & Hanna, Gulf of California
5. *Æsopus arestus* Dall, Magdalena Bay.
6 *Alaba jeanetta* Bartsch, San Pedro to Gulf of California
7. *Alabina* sp.
8 *Alvania aequisculpta* Keep; Catalina to Todos Santos Bay
9. *Alvania cosmia* Bartsch; San Pedro to San Martin Island
10 *Alvania oldroydae* Bartsch; San Pedro to Coronado Island. This species is present in large numbers.
11 *Alvania purpurea* Dall, Monterey to San Martin Island
12 *Amphithalamus inclusus* Carpenter, Monterey to San Martin Island.
13 *Amphithalamus tenuis* Bartsch, Monterey to Magdalena Bay.
14 *Anachis subturrita* Carpenter; San Pedro to Todos Santos Bay
15 *Arca solida* Broderip & Sowerby, San Pedro to Peru This rock loving species is represented by a single valve and belongs to the dwarfed form of the southern California coast
16. *Astraea undosus* Wood; San Pedro to Cedros Island.
17 *Barleeia californica* Bartsch, San Pedro to Abreojos Point
18 *Bittium interfossa* Carpenter, Monterey to San Diego.
19 *Bursa californica* Hinds, Monterey to Cedros Island.
20 *Caecum californicum* Dall, Monterey to Lower California
21. *Cadulus fusiformis* Pilsbry & Sharp, Monterey to Cape San Lucas
22 *Calliostoma splendens* Carpenter, Monterey to San Diego
23 *Capulus californicus* Dall, San Pedro to San Diego
24 *Cerithiopsis* sp.
25 *Cerithiopsis oxys* Bartsch; San Pedro to Abreojos Point.
26 *Chama pellucida* Sowerby, Oregon to Chile.
27. *Circulus rossellinus* Dall, San Diego
28. *Crenella divaricata* d'Orbigny, Santa Barbara Islands to Panama. This species was described from Cuba Numerous valves and a few pairs seem to be the same as the west coast form said by Dall to be identical.
29 *Crepidula lingulata* Gould; Bering Sea to Panama
30 *Cystiscus politulus* Dall; Santa Barbara to Cape San Lucas
31 *Cypraeolina pyriformis* Carpenter, Sitka to Mazatlan.
32 *Diastoma* sp
33 *Fartulum hemphilli* Bartsch, San Pedro to Abreojos Point.
34. *Fissurella volcano* Reeve, Crescent City to Panama.

35. *Glycymeris* sp.

36. *Grippina californica* Dall, San Diego. This species, previously known from the type locality only, is represented by a dozen pairs and several odd valves.

37 *Haliotis californiensis* Stearns, Santa Barbara to Guadalupe Island.

38 *Haliotis corrugata* Gray, Monterey to San Quentin Bay

39 *Haliotis cracherodii* Leach, Coos Bay to Santa Rosalia

40 *Haliotis fulgens* Philippi, Farallons to Gulf of California.

41. *Hipponix antiquatus* Linnæus, Crescent City to Panama

42 *Hipponix tumens* Carpenter, Crescent City to San Diego

43 *Hyalina californica* Tomlin, San Pedro to Puerto Libertad.

44 *Iselica fenestrata* Carpenter, Puget Sound to Gulf of California

45. *Leptothyra paucicostata* Dall, Monterey to Coronado Islands.

46 *Liotia acuticostata* Carpenter; Catalina to Magdalena Bay.

47 *Liotia cookeana* Dall, Coronado Islands to Gulf of California.

48 *Littorina planaxis* Philippi, Puget Sound to Magdalena Bay.

49 *Lottia gigantea* Gray, Crescent City to Cedros Island.

50 *Macrocallista pannosa* Sowerby; Gulf of California to Chile. This species is represented by many valves, mostly young.

51 *Mangilia beta* Dall, Point Año Nuevo to Coronado Islands

52 *Margarites acuticostata* Carpenter; Bodega Bay to Coronado Islands

53. *Margarites parcipicta* Carpenter; Sitka to San Diego Specimens of this species are the most numerous in the collection

54 *Marginella jewettii* Carpenter, Monterey to San Diego

55. *Metaxia diadema* Bartsch, Monterey to Point Loma

56. *Milneria kelseyi* Dall, Monterey to Abreojos Point

57 *Nodulus kelseyi* Bartsch, San Pedro to South Coronado Island

58 *Norrisia norrisii* Sowerby, California to Cedros Island

59 *Odostomia æpynota* Dall & Bartsch, San Pedro to Cape San Lucas This is one of the few abundant species found, about 300 specimens were taken

60 *Odostomia clementina* Dall & Bartsch, San Clemente and Santa Catalina Islands

61 *Odostomia deceptrix* Dall & Bartsch, San Hipolito and Abreojos points

62 *Odostomia eucosmia* Dall & Bartsch, San Pedro to Abreojos Point

63 *Odostomia nansa* Dall & Bartsch, San Pedro to Scammon Lagoon

64. *Odostomia turricula* Dall & Bartsch, Monterey to Abreojos Point.

65. *Odostomia virginalis* Dall & Bartsch; San Pedro to Abreojos Point

66 *Phacoides californica* Conrad, Crescent City to San Ignacio.

67. *Phasianella pulloides* Carpenter, Puget Sound to Gulf of California

68 *Phasianella rubrilineata* Strong, San Pedro to Todos Santos Bay

69. *Philobrya setosa* Carpenter, Forrester Island to Gulf of California.

70 *Psephidia cymata* Dall; Santa Barbara Island to Gulf of California. This species is the most numerous of the bivalves.
71 *Puncturella cooperi* Carpenter, Alaska to Santa Rosa Island.
72 *Retusa harpa* Dall, British Columbia to San Martin Island
73 *? Rissoella* sp
74 *Rissoina* sp
75 *Rissoina* sp
76 *Rissoina* sp
77 *Rissoina californica* Bartsch, Catalina to South Coronado Island.
78 *Rissoina cleo* Bartsch, Catalina to South Coronado Island
79 *Seila montereyensis* Bartsch; Monterey to Todos Santos Bay
80 *Siphonodentalium quadrifissatum* Carpenter; San Pedro to San Diego
81 *Tegula gallina* Forbes, San Francisco to Gulf of California
82 *Tegula regina* Stearns, San Clemente Island to Gulf of California
83 *Teinostoma invallata* Carpenter, Monterey to Gulf of California
84 *Teinostoma supravallata* Carpenter; Monterey to Gulf of California.
85. *Triphora pedroana* Bartsch, San Pedro to South Coronado Island
86 *Vermiculum anellum* Morch, Monterey to Todos Santos Bay
87 *Williamia peltoides* Carpenter, Catalina to Gulf of California

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XIX, No. 2, pp 7-12 JUNE 4, 1930

II

MARINE MOLLUSCA OF THE REVILLAGIGEDO ISLANDS, MEXICO

BY

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AND

G D HANNA

This report properly constitutes a part of the records of the expedition of the California Academy of Sciences of 1925 to various west Mexican islands [1] The collecting of marine mollusca was placed in the hands of Eric K Jordan and G D Hanna who had a special request from Dr. W H Dall to do the task as thoroughly as possible at Clarion and Socorro islands. It appears that no previous visitors to these little-frequented places had brought back more than a scattering of shells and these were not sufficient to permit the determination of the relationships of the group Indeed, Dr Dall was led to suppose from the few he had seen from Clarion Island[2] that an Indo-Pacific fauna was dominant there Stearns[3] in 1894 stated that "Of Socorro, the principal island of the more distant Revillagigedo group, we know but little or nothing It was visited several years ago by Grayson, the ornithologist

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[1]For a general account of this expedition, see Proc Calif Acad Sci, ser 4, vol. 15, no 1, pp 1-113, pls. 1-10, text figs. 1-7, March 30, 1926. Various technical reports based upon the collections obtained have appeared subsequently

[2]Dall & Ochsner, Proc. Calif Acad. Sci., ser 4, vol 17, no 5, 141-185, June 22, 1929.

[3]Stearns, Proc U S Nat Mus, vol. 17 1894, p 143

The few marine shells that have been brought from there are, as would be supposed, familiar Gulf [of California] forms."

The collection enumerated herein came from Socorro and Clarion islands. The smaller San Benedicto and Roca Partida were visited but it was found impracticable to secure any shells The two larger islands are volcanic with extremely steep submarine slopes Coral grows in some places but sandy beaches are practically wanting. On the south side of Clarion Island there is a broken coral beach with spots of sand off shore where a limited amount of dredging was practicable, results were rather indifferent. The chart shows a small sand beach near the west end of Socorro Island but rough weather prevented the investigation of it As a consequence of these physical barriers, collecting had to be confined almost exclusively to shallow waters close in shore A few beach shells were picked up but most of the collection came from between tides or within reach of a bather below low water A few species, not otherwise collected, were brought up in the dredge from about 30 fathoms on the south side of Clarion Island The bottom consisted of rounded chunks of coral and coraline algæ Had a good patch of shell sand been found this list would undoubtedly be greatly lengthened

As it is, the list contains the records of 61 species and they do not bear out the suppositions of either Stearns or Dall Only two species can be said to belong to the Indo-Pacific region Many of the species are widely distributed along west American shores Eighteen are known from the southern California coast or islands, and four of these have not previously been recorded from as far south as the Gulf of California (The Revillagigedos are about 240 miles south of Cape San Lucas) The remainder, 41 species, would seem more properly to belong with the Galapagos Islands or Panamanian faunas than with that of the Gulf of California

The nearest places from which lists of shells have heretofore been published are the Tres Marias Islands, 300 miles east northeast, and Cape San Lucas 240 miles north From the first locality Stearns[4] recorded 89 species of which 22 were

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[4]Stearns, Proc U S. Nat. Mus., vol. 17, 1894, pp. 139-204. See next paper of Proc. Calif. Acad Sci , ser 4, vol. 19, for a larger list of species from the Tres Marias Islands.

found at Socorro and Clarion. Out of eight of his species known to range as far north as California, four were found at Socorro and Clarion.

Carpenter's[5] list of 360 species from Cape San Lucas, Lower California, did not include 30 forms found at Socorro and Clarion islands Of the 18 species from the islands known to extend as far north as California, only eight have been listed from the Cape.

Such records as these make it appear almost certain that the marine mollusca have the character of a waif fauna Species have arrived from hither and yon with little guide but chance The islands have probably not been connected to the mainland, even by a shallow submarine ridge, during late geologic time, and they do not seem to have existed at all for a sufficiently long period for the mollusca to have developed insular species The land faunas and floras bear out these suppositions except that many of the groups are sufficiently plastic to have developed insular forms during the time the islands have been above water.

Prior to the departure of the expedition it had been anticipated that the Revillagigedos would furnish a far-flung offshot of the wonderful south sea fauna with many strange things added or evolved Such a discovery was not to be made.

Clarion and Socorro islands are about 60 miles apart and the intervening waters are supposed to be very deep, yet marine shells of the two islands are very similar Many of the species were collected at both places and it is probable that the close relationship would be further strengthened had not the collecting stations been somewhat different in physical characters. There was a great deal of coral in evidence about Clarion Island, while on Socorro where collections were made there was very little

[5]Carpenter, Smith, Misc Coll, vol 10, no 252, 1872, pp 616-628.

LIST OF SPECIES FOUND ON THE REVILLAGIGEDO ISLANDS

1 *Acmæa discors* Philippi Clarion and Socorro islands, numerous specimens from each Range Gulf of California

2 *Acteocina smirna* Dall A few specimens were collected on Clarion Island. Range Laguna Beach, California to San Salvador

3 *Anachis coronata* Sowerby Socorro, several specimens Range Cedros Island, Mexico to Panama

4 *Arca solida* Broderip & Sowerby Clarion Island, a large number of specimens Range San Pedro, California to Peru

5 *Bittium nicholsi* Bartsch Clarion Island, one specimen Range. Gulf of California

6 *Bursa albifasciata* Sowerby Clarion Island, one specimen, Socorro Island, seven Range· Panama Tryon considered this a subspecies of *Bursa nana* Broderip & Sowerby, but it seems to be specifically distinct

7 *Cassidea abbreviata* Lamarck Clarion Island, one specimen Range· Gulf of California to Ecuador

8 *Cerithium maculosum* Kiener Clarion and Socorro islands, a few specimens from each Range Lower California to Panama

9 *Codakia distinguenda* Tryon [6] Clarion Island, one beach shell Range Gulf of California to Panama

10 *Collisella æruginosa* Middendorf Socorro Island, several specimens Range Gulf of California to Peru This species is often listed as *Scurria mesoleuca* Menke

11. *Conus brunneus* Mawe Clarion Island, abundant Range. Gulf of California to Ecuador

12 *Conus gladiator* Broderip Clarion and Socorro islands, several specimens from each Range Gulf of California to Ecuador.

13 *Conus purpurascens* Broderip. Clarion Island, several specimens Range. Magdalena Bay, Lower California to Peru

14 *Coralliophila costata* Blainville Socorro Island, four specimens Range San Miguel Island, California to Panama.

15. *Coralliophila neritoidea* Lamarck. Clarion Island, two specimens, Socorro Island, one. This is a south Pacific shell not heretofore reported from west America

16 *Coralliophila nux* Reeve Clarion Island, one specimen, Socorro Island, several. Range Gulf of California to Panama

17 *Crepidula aculeata* Gmelin Clarion Island, one specimen Range Port Harford, California to Chile

18 *Cymatium vestitum* Hinds Socorro Island, eight specimens Range Cedros Island, Mexico to Peru.

19 *Cypræa albuginosa* Gray Socorro Island, several specimens Range Gulf of California to Galapagos Islands

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[6] This is *Lucina (Codakia) distinguenda* Tryon, Proc Acad. Nat. Sci Phila., 1872, p 130, pl 6, fig 3, also *Codakia colpoica* Dall, Proc U S Nat Mus., vol 23, 1901, p 821, formerly called *Lucina tigrina*

20 *Cypræa isabella-mexicana* Stearns Socorro Island, four specimens. Range· Tres Marias Islands, Mexico

21 *Cypræcassis tenuis* Gray Clarion Island, one specimen over five inches long. Range Gulf of California to Galapagos Islands

22. *Cypræolina margaritula* Carpenter Clarion Island, one specimen Range Gulf of California

23 *Diadora inæqualis* Sowerby Clarion Island, three specimens, Socorro Island, two Range Santa Barbara, California to Ecuador

24 *Diadora panamensis* Sowerby Clarion Island, four specimens Range Gulf of California to Peru This species is sometimes listed as *Fissuridea alta* C B Adams

25 *Diplodonta subquadrata* Carpenter Clarion Island, a large number of specimens taken from coral heads Range Catalina Island, California to Peru

26 *Epidromus nitidulus* Sowerby Socorro Island, eight specimens This is a south Pacific species not heretofore recorded from west America

27 *Fissurella obscura* Sowerby Socorro Island, three specimens Range Lower California to Peru,

28 *Fissurella volcano* Reeve Clarion Island, several specimens Range Crescent City, California to Panama

29 *Fundella caudeana* d'Orbigny Clarion Island, a large number of specimens collected from coral heads This species was figured by Reeve from Isla Plata as *Malleus vesiculatus*, but Dr Johnson (Nautilus, Vol 32, p 38) has recently placed that name in the synonymy of *F caudeana*, originally described from the West Indies

30 *Gadinia peruviana* Sowerby Socorro Island, several specimens Range Gulf of California to Chile

31 *Gastrochæna ovata* Sowerby Clarion Island, numerous specimens taken from coral heads Range Gulf of California to Panama

32 *Heliacus radiatus* Menke Clarion Island, one specimen, Socorro Island, one Range. Magdalena Bay, Lower California to Panama The species is usually listed as *Solarium variegatum* Gmelin

33 *Hipponix barbatus* Sowerby Socorro Island, several specimens Range Crescent City, California to Panama

34 *Hipponix tumens* Carpenter Clarion Island, two specimens Range Crescent City, California to San Martin Island, Lower California.

35 *Lacuna unifasciata* Carpenter Clarion Island, four specimens Range Puget Sound to Magdalena Bay, Lower California. This is the southernmost record of the genus

36 *Latirus concentricus* Reeve Clarion and Socorro islands, abundant Range. Acapulco, Mexico to Panama

37 *Leptothyra lurida* (?) Dall Clarion Island, four beach worn shells, too badly broken for positive determination Range Puget Sound to Peru

38. *Liotia* sp. Socorro Island, 12 specimens

39 *Lithophaga calyculatus* Carpenter Clarion Island, a large number of specimens taken from coral heads Range Gulf of California

40. *Littorina conspersa* Philippi Socorro Island, abundant Range· Gulf of California to Ecuador

41. *Littorina scutulata* Gould. Clarion and Socorro islands, abundant. Range: Alaska to Socorro Island

42 *Marginella californica* Tomlin Clarino Island, six specimens; Socorro Island, one specimen Range: San Pedro, California to Puerto Libertad

43 *Marginella regularis* Carpenter Clarion Island, two specimens Range Monterey, California to Gulf of California

44 *Modulus cerodes* A Adams Socorro Island, one specimen Range Magdalena Bay, Lower California to Panama

45 *Murex radicata* Hinds Clarion Island, several specimens, Socorro Island, many Dall has placed this name in synoymy of *Murex lappa* Broderip, but Tryon and Reeve have held it distinct

46 *Nerita bernhardi* Reclus Socorro Island, several specimens Range Gulf of California to Peru

47 *Nerita scabricosta* Lamarck. Socorro Island, a large number of specimens Range. Lower California to Peru

48 *Olivella gracilis* Sowerby Clarion Island, one specimen Range Gulf of California to Panama

49. *Pedalion chemnitzianum* d'Orbigny Clarion Island, three specimens Range Coronado Island, Lower California to Chile

50 *Phyllonotus radix* Gmelin Clarion Island, one specimen. Range. Magdalena Bay, Lower California to Peru.

51 *Pyrene (Mitrella) carinata californiana* Gaskoin Clarion Island, three specimens Range Alaska to Salina Cruz, Mexico.

52 *Pyrene fuscata* Sowerby. Clarion and Socorro islands, common. Range Gulf of California to Galapagos Islands

53 *Pyrene (Mitrella) ocellata* Gmelin. Clarion Island, one specimen, Socorro Island, several specimens. Range: Gulf of California to Peru. The species is frequently listed as *Nitidella cribraria* Lamarck

54 *Rissoina stricta* Menke Socorro Island, several specimens. Range Gulf of California

55 *Strigatella tristis* Swainson. Socorro Island, several specimens. Range Gulf of California to Panama.

56 *Thais patula* Linnæus Clarion and Socorro islands, very abundant in all stages of growth. Range: Gulf of California to Peru.

57 *Thais planospira* Lamarck Clarion and Socorro islands, common Range Lower California to Peru.

58 *Tritonalia circumtexta* Stearns. Clarion Island, one specimen. Range. Trinidad, California to Scammon Lagoon, Lower California.

59. *Tritonalia* sp Socorro Island, eight specimens. The species has not been satisfactorily identified.

60 *Truncatella stimpsoni* Stearns. Clarion Island, three specimens Range: Catalina Island, California to Magdalena Bay, Lower California.

61 *Turbo fluctuosum* Wood. Clarion and Socorro islands; large numbers of specimens from each, showing all stages of growth; some adult individuals are over three inches in diameter. Range: Gulf of California to Peru

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OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL XIX, No 3, pp 13-22 JUNE 4, 1930

III

MARINE MOLLUSCA OF THE TRES MARIAS ISLANDS, MEXICO

BY
A. M STRONG
AND
G D HANNA

The expedition of the California Academy of Sciences to the Revillagigedo Islands in 1925[1] stopped for nine days in May at the Tres Marias Islands, 200 miles southeast of Cape San Lucas, Lower California The attention of various members of the party was largely devoted to other duty, but a considerable number of marine mollusks was secured in the progress of other work. Dredging was done at one locality off the east side of Maria Madre Island in front of the penal settlement in 10 to 25 fathoms The remainder of the material from this island was secured along the east shore from the salt works on the south to a point about four miles north of the penal settlement All of the collection from Maria Magdalena Island was obtained along the north shore about the center in an east-west direction

In 1894 Stearns[2] published an annotated list of 89 species from the Tres Marias Islands collected by W. J. Fisher, in 1876, chiefly on Maria Madre Island

[1]For a general account of the expedition of 1925 see Hanna, Proc Calif Acad. Sci., ser 4, vol 15, no. 1, 1926, pp 1-113, pls. 1-10, text figs. 1-7

[2]Stearns, Proc. U S. Nat. Mus., vol. 17, 1894, pp. 139-204.

On comparing that list with the present one, many differences will be noted. These lead to the belief that Fisher probably collected on the west side of the island as well as the east The east side is the more protected from the ocean swell of the Pacific and probably fewer large shells are thrown up there for that reason

The fauna is found to be similar to that long known from the Gulf of California, however, an unsuspected number of migrants from nothern waters appeared.

In the list below, those species which were also included in Stearns' paper are indicated thus. (S). Those for which there is a notable increase in range from the north are indicated by (N) The list includes 211 species About 20 others have been omitted because of our inability to identify them with described forms Those which may prove to be new will be considered in the series of papers on west Mexican Mollusca, being published from time to time, by Baker, Hanna and Strong

We are under obligation to Professor Francisco Contreras, a member of the expedition, for permitting us to include in the list such species as he was able to collect In so far as the available series of specimens has permitted, a suite of each species has been deposited in the National Museum of Mexico. Another set has been deposited in the U S National Museum, and various forms have been transferred to the collections of A M Strong and Fred Baker The same statements apply as to disposition of material to the collections reported upon in the two preceding papers

Pelecypoda and Scaphopoda

1 *Antigona rigida* Dillwyn Maria Magdalena, five valves. If the Pacific shell is considered as distinct from the West Indian it will take the name of *A isocardia* Verrill, 1870

2 *Arca formosa* Sowerby Maria Magdalena, one valve

3 *Arca multicostata* Sowerby Maria Madre; very common

4 *Arca mutabilis* Sowerby (S) Maria Madre, one specimen, Maria Magdalena, five specimens

5 *Arca pacifica* Sowerby Maria Madre, two valves

6 *Arca reticulata* Gmelin Maria Madre, three valves

7 *Arca solida* Broderip & Sowerby. Maria Madre, two specimens

8 *Botula cinnamoneus* Chemnitz Maria Madre, five specimens in a piece of rock. These seem to agree with Reeve's figure, "*Lithodomus* sp 3," which he listed from the Philippines and the West Indies. Carpenter listed the species from Mazatlan, "No 177," on the strength of a single valve

9 *Cardita laticostata* Sowerby Maria Magdalena, three specimens and six odd valves

10 *Cardium apicinum* Carpenter Maria Madre, many specimens This is said to be the same as *C elenense* Sowerby from South America, but the small, smooth Gulf form seems to be really distinct

11 *Cardium biangulatum* Sowerby Maria Madre, a few valves and many young specimens

12 *Cardium consors* Broderip & Sowerby Maria Madre, a few valves and young specimens, Maria Magdalena, two valves

13 *Cardium pristipleura* Dall Maria Madre, three valves, Maria Magdalena, three valves This is *C maculosum* of authors, not Wood

14 *Chama spinosa* Broderip Maria Madre, 10 valves, Maria Magdalena, three valves

15 *Chione undatella* Sowerby (S) Maria Madre, very common

16 *Codakia distinguenda* Tryon Maria Madre, three valves, Maria Magdalena, six valves

17 *Codakia mexicana* Dall Maria Madre, 12 valves This is *Lucina pectinata* Carpenter, not Gmelin

18 *Corbula speciosa* Hinds Maria Magdalena, one valve

19 *Crenella divaricata* d'Orbigny Maria Madre, six specimens Dall stated that the gulf shells are identical with this West Indian species Carpenter described it as *C inflata*

20 *Cumingia lamellosa* Sowerby Maria Madre, 10 specimens Carpenter listed three species from Mazatlan but Dall united them under this name Our specimens belong to what Carpenter called *C trigonularis* Sowerby

21 *Cyathodonta dubiosa* Dall (N) Maria Madre, four valves

22 *Dentalium fischeri* Stearns (N) Maria Madre, about 20 specimens

23 *Dentalium semipolitum* Pilsbry & Sharp (N) Maria Madre, about 100 specimens.

24 *Divaricella lucasana* Dall & Ochsner Maria Madre, many valves. This species is commonly listed as *D eburnea* (Reeve) 1850, but not of Deshayes, 1835

25 *Gastrochaena ovata* Sowerby Maria Madre, several specimens from holes in a rock

26 *Glycymeris inaequalis* Sowerby Maria Madre, several specimens, young and adult; Maria Magdalena, a few odd valves

27. *Glycymeris multicostata* Sowerby Maria Madre, very common, mostly young

28. *Glycymeris pectenoides* Deshayes. Maria Madre, very common.

29 *Leda acuta* Conrad (N.) Maria Madre; two specimens.

30. *Lithophaga aristata* Dillwyn Maria Madre, two specimens in a piece of coral rock

31 *Lithophaga plumula* Hanley Maria Madre, one specimen in a piece of coral rock

32 *Lyonsia gouldii* Dall. (N) Maria Madre, five valves.

33. *Macrocallista squalida* Sowerby Maria Madre, very common

34 *Modiolus capax* Conrad Maria Magdalena, one specimen.

35. *Modiolus corallioophagus* Gmelin. Maria Madre, several specimens from holes in a piece of coral rock. This is said to be the same as the West Indian species more commonly known under the name of *M opifex* Say

36 *Mytilus multiformis* Carpenter (S) Maria Madre, two adult and many young specimens.

37 *Ostrea chilensis* Dall. Maria Madre, six valves

38 *Pecten cataractes* Dall Maria Madre, two valves.

39 *Pecten circularis* Sowerby Maria Madre, 20 valves, Maria Magdalena, five valves

40 *Pecten subnodosus* Sowerby Maria Madre, one valve; Maria Magdalena, four valves

41. *Pedalion chemnitzianum* d'Orbigny. Maria Madre, six specimens from shore and many from holes in a piece of rock, Maria Magdalena, six specimens

42 *Petricola robusta* Sowerby. Maria Madre, five specimens from a piece of coral rock.

43 *Phacoides approximatus* Dall. Maria Madre, many valves.

44 *Phacoides lamprus* Dall Maria Madre, many adult valves and young specimens.

45 *Phacoides nuttalli* Conrad. (N.) Maria Magdalena, two valves.

46. *Pinctada fimbriata* Dunker The pearl oyster Maria Madre, several specimens.

47. *Pitaria vulnerata* Broderip. Maria Madre, very common

48. *Psammobia fucatus* Hinds. Maria Madre, a few young

49. *Pteria sterna* Gould Maria Madre, two specimens

50 *Siphodentalium quadrifissatum* Carpenter. (N) Maria Madre, about 20 specimens

51 *Spondylus calcifer* Carpenter. Maria Madre, one specimen.

52 *Tagelus ? affinis* C B Adams. Maria Madre, four young specimens.

53 *Tellina cumingii* Hanley. Maria Madre, five valves

54 *Tellina ochracea* Carpenter Maria Madre, two adult and several young valves

55 *Tellina panamensis* Dall Maria Madre, very common.

56 *Venericardia flammea*[3] Michelin. Maria Magdalena, 12 valves.

57 *Venericardia crassicostata*[4] Sowerby. Maria Madre, two valves, Maria Magdalena, 10 valves.

GASTROPODA

58 *Acanthina muricata* Broderip Maria Madre, five specimens, Maria Magdalena, three specimens.

59. *Acmæa discors* Philippi (S.) Maria Magdalena, one specimen.

60. *Acmæa limatula* Carpenter. Maria Madre, 20 specimens.

61 *Acmæa rosacea* Carpenter Maria Madre, several specimens.

62. *Acteocina angustior* Baker & Hanna. Maria Madre, about 500 specimens.

63 *Alaba supralirata* Carpenter. Maria Madre, several hundred specimens

64 *Alabina diomedeæ* Bartsch Maria Madre, 10 specimens.

65 *Alabina occidentalis* Hemphill. (N.) Maria Madre, 40 specimens

66 *Alectrion pagoda corpulenta* C B Adams (S) Maria Madre, several specimens

67 *Alectrion versicolor* C B Adams Maria Madre, 12 specimens

68 *Aletes squamigerus* Carpenter Maria Madre, several specimens

69 *Alvania tumida* Carpenter. Maria Madre, 40 specimens

70 *Anachis pygmæa* Sowerby Maria Madre, 20 specimens

71 *Anachis subturrita* Carpenter (N) Maria Madre, 10 specimens.

72. *Architectonica granulata* Lamarck (S) Maria Madre, several young specimens

73 *Astræa olivaceum* Mawe. Maria Madre, two specimens, Maria Magdalena, nine specimens

74 *Astræa unguis* Mawe. Maria Madre, three specimens, Maria Magdalena, four specimens

75 *Barleeia alderi* Carpenter Maria Madre, 40 specimens

76 *Bullaria punctulata* A Adams. Maria Madre, one adult and many young specimens; Maria Magdalena, one specimen

77 *Cæcum ? clathratum* Carpenter Maria Madre, four specimens

78 *Calyptræa mammillaris* Broderip (S) Maria Madre, 12 specimens.

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[3]*Venericardia flammea* MICHELIN, Mag de Zool. 1830. pl 6—REEVE, Conch. Icon [*Cardita*], 1843, pl. 8, fig. 38, [as *Cardita*]

Venericardia crassicostata SOWERBY, DALL, Proc. U S. Nat. Mus., vol. 37, 1909, p. 261, not SOWERBY, Tankerville Catalog 1825, App. p. iv

Cardita varia BRODERIP, Proc. Zool. Soc. 1832, p. 56.—REEVE, Conch. Icon [*Cardita*], 1843, pl. 5, figs. 25 *a*, *b*.

Cardita tumida BRODERIP, Proc. Zool. Soc. 1832, p. 56—REEVE, Conch. Icon. [*Cardita*], 1843, pl. 5, fig 26.

[4]*Cardita crassicostata* SOWERBY, Tankerville Catalog. 1825, App. p iv—WOOD, Index Test. Suppl. 1828, p. 204, pl 2, [*Chama*], fig. 5, [reference from 1856 Ed.]

Cardita cuvieri BRODERIP, Proc. Zool. Soc. 1832, p. 55—REEVE, Conch. Icon. [*Cardita*], 1843, pl. 5, fig. 24.

79 *Cantharus gemmatus* Reeve. Maria Madre, one specimen.

80. *Cantharus sanguinolentus* Duclos Maria Madre, seven specimens; Maria Magdalena, five specimens.

81 *Cassidea abbreviata* Lamarck Maria Madre, one specimen.

82 *Cerithium maculosum* Kiener (S) Maria Madre, 12 specimens, Maria Magdalena, three specimens

83 *Cerithium uncinatum* Gmelin Maria Madre, 30 specimens

84 *Clava gemmatum* Hinds (S) Maria Madre, many specimens

85 *Conus brunneus* Mawe (S) Maria Madre, one specimen

86 *Conus dalli* Stearns (S) Maria Madre, four specimens

87 *Conus princeps* Lamarck Maria Madre, three specimens, Maria Magdalena, seven specimens

88 *Conus purpurascens* Broderip (S) Maria Madre, five specimens, Maria Magdalena, 12 specimens.

89 *Conus tornatus* Broderip Maria Madre, many specimens, mostly young

90 *Coralliophila neritoides* Lamarck Maria Madre, 12 specimens

91 *Coralliophila nux* Reeve Maria Madre, two specimens

92 *Crassispira aterrima* Sowerby Maria Madre, one specimen

93 *Crepidula aculeata* Gmelin Maria Madre, nine specimens

94 *Crepidula excavata* Broderip Maria Madre, many specimens

95 *Crepidula exuviata* Nuttall Maria Madre, one specimen

96 *Crepidula incurva* Broderip Maria Madre, two specimens

97 *Crucibulum imbricatum* Sowerby. (S) Maria Madre, many specimens

98 *Crucibulum spinosum* Sowerby (S) Maria Madre, many specimens

99 *Cylichnella fantasma* Baker & Hanna Maria Madre, 23 specimens

100 *Cymatium pileare* Linnæus Maria Madre, two specimens

101 *Cymatosyrinx ægina* Dall Maria Madre, 25 specimens

102 *Cymatosyrinx æolia* Dall Maria Madre, 20 specimens.

103 *Cypræa albiginosa* Gray (S) Maria Madre, three specimens, Maria Magdalena, eight specimens

104 *Cypræa arabicula* Lamarck. (S) Maria Madre, seven specimens, Maria Magdalena, six specimens

105 *Cypræa cervinetta* Kiener Maria Madre, six specimens

106 *Cypræa isabella-mexicana* Stearns (S.) Maria Magdalena, four specimens

107 *Cypræcassis coarctata* Wood (S) Maria Magdalena, four specimens

108 *Cypræolina margaritula* Carpenter Maria Madre, several hundred specimens

109 *Cysticus politulus* Dall. (N) Maria Madre, about 100 specimens

110 *Cytharella penelope* Dall Maria Madre, 18 specimens.

111 *Cytharella phæthusa* Dall. Maria Madre, nine specimens.

112 *Diadora inæqualis* Sowerby (S) Maria Madre, two specimens.

113 *Diadora panamensis* Sowerby (S.) Maria Magdalena, eight specimens This is *F. alta* C. B. Adams

114 *Daphnella bartschi* Dall Maria Madre, one specimen

115 *Elephantanellum heptagonum* Carpenter Maria Madre, several hundred specimens Carpenter's description was based on a single broken specimen but the species seems to be very distinct The ribs are not uniformly seven in number

116 *Engina rufonotata* Carpetner Maria Madre, nine specimens

117 *Epitonium (Nitidoscala) ? apiculatum* Dall Maria Madre, two specimens

118 *Epitonium (Nitidoscala) bialatum* Dall. Maria Madre, five specimens

119 *Epitonium (Asperoscala) canna* Dall. Maria Magdalena, one specimen

120 *Epitonium (Nodiscala) retiporosum* Carpenter (N.) Maria Madre, nine specimens

121 *Epitonium (Asperoscala) xantusi* Dall Maria Madre, nine specimens

122 *Fasciolaria princeps* Sowerby Maria Madre, several specimens

123 *Fissurella rugosa* Sowerby Maria Madre, one specimen, Maria Magdalena, two specimens

124. *Fissurella virescens* Sowerby Maria Madre, one specimen, Maria Magdalena, 10 specimens

125 *Fusinus taylorianus* Reeve Maria Madre, several young specimens

126 *Haminœa angelensis* Baker & Hanna Maria Madre, several young specimens

127 *Harpa crenata* Swainson (S.) Maria Magdalena, two specimens

128 *Hipponix barbatus* Sowerby (S.) Maria Madre, two specimens

129 *Hipponix antiquatus* Linnæus Maria Madre, one specimen

130 *Hipponix grayanus* Menke. Maria Madre, many specimens

131 *Hyalina californica* Tomlin Maria Madre, 12 specimens of a small, pale variety

132 *Iselica ovoidea* Gould Maria Madre, 61 specimens in all stages of growth The variation in this lot makes it seem quite probable that *I maculosa* Carpenter (Mazatlan Catalogue No 406), was described from a young, well marked specimen of this species

133 *Lamellaria stearnsii* Dall (N.) Maria Madre, six young specimens.

134 *Lamprodoma volutella* Lamarck Maria Magdalena, one very large specimen

135 *Latirus ceratus* Gray (S.) Maria Magdalena, one specimen

136 *Liotia acuticostata* Carpenter (N.) Maria Madre, 20 specimens

137 *Liotia rammata* Dall Maria Madre, many specimens

138 *Littorina conspersa* Philippi (S.) Maria Madre, 85 specimens.

139 *Littorina philippii penicillata* Carpenter Maria Madre, 13 specimens

140 *Littorina pullata* Carpenter Maria Madre, many specimens Some authors list this as identical with the northern *L. scutulata* Gould

141 *Malea ringens* Sowerby Maria Madre and Maria Magdalena, several specimens.

142. *Marginella phrygia* Sowerby. Maria Madre, four specimens.

143. *Mangelobennus bimaculatus* Dall. (N.) Maria Madre, one specimen.

144 *Melanella baldra* Bartsch. Maria Magdalena, one specimen

145 *Melanella mexicana* Bartsch. Maria Madre, 27 specimens.

146. *Metaxia convexa* Carpenter Maria Madre, nine specimens

147 *Micranellum ? elongatum* Carpenter Maria Madre, one specimen

148 *Mitra funiculata* Reeve. Maria Madre, one specimen

149 *Mitra lens* Mawe. (S) Maria Magdalena, nine specimens

150. *Mitrella ocellata* Gmelin (S) Maria Magdalena, eight specimens. This is *Nitidella cribraria* of many authors

151 *Modulus cerodes* A Adams (S) Maria Madre, 18 specimens

152 *Morum tuberculosum* Sowerby. (S) Maria Magdalena, two specimens

153 *Murex bicolor* Valenciennes Maria Magdalena, one specimen

154 *Murex recirostris* Sowerby. Maria Madre, one specimen.

155 *Natica catenata* Philippi Maria Madre, several young specimens.

156 *Nerita bernhardi* Reclus (S) Maria Madre, one specimen

157. *Odostomia* (*Miralda*) *aepynota* Dall & Bartsch. Maria Madre, six specimens

158 *Odostomia* (*Chrysallida*) *deceptrix* Dall & Bartsch Maria Madre, one specimen.

159 *Odostomia* (*Chrysallida*) *? lapazana* Dall & Bartsch Maria Madre, one young specimen.

160 *Odostomia* (*Salassia*) *scalariformis* Carpenter. Maria Madre, about 40 specimens

161 *Odostomia* (*Chrysallida*) *vizcainoana* Baker, Hanna & Strong Maria Madre, 20 specimens

162 *Oliva kiatula* Duclos. (S) Maria Magdalena, four specimens This species is listed as *O testacea* Lamarck by many authors

163. *Olivella gracilis* Sowerby Maria Madre, a number of young specimens, Maria Magdalena, 15 specimens.

164 *Olivella undatella* Lamarck. Maria Magdalena, five specimens

165 *Parametaria dupontii* Kiener (S) Maria Magdalena, five specimens This is *Conella cedonulli* of many authors

166 *Patella mexicana* Broderip & Sowerby (S) Maria Magdalena, several specimens.

167 *Phasianella typicum* Dall. (S) Maria Madre, nine specimens, Maria Magdalena, one specimen This is *P variegata* Carpenter

168 *Philbertia affinis* Dall. (N) Maria Madre, three specimens

169 *Philbertia trichodes* Dall Maria Madre, many specimens

170 *Phyllonotus princeps* Broderip Maria Madre, one specimen

171. *Phyllonotus regius* Swainson. Maria Magdalena, two specimens.

172 *Polinices uber* Valenciennes. Maria Madre, about 20 specimens, mostly young

173 *Pustularia pustulata* Lamarck. (S) Maria Madre, one specimen, Maria Magdalena, three specimens.

174 *Pyramidella hastata* A Adams Maria Madre, one specimen

175 *Pyrene fuscata* Sowerby (S) Maria Madre, 20 specimens, Maria Magdalena, 24 specimens

176 *Pyrene hæmastoma* Sowerby Maria Madre, about 50 specimens

177 *Pyrene major* Sowerby Maria Madre, one specimen, Maria Magdalena, six specimens

178 *Rissoina firmata* C B Adams Maria Madre, one specimen

179 *Rissoina stricta* Menke Maria Madre, one specimen

180 *Seila assimilata* C B Adams Maria Madre, about 100 specimens

181 *Siphonaria maura lecania* Philippi Maria Madre, four specimens

182 *Siphonaria maura palmata* Carpenter Maria Madre, seven specimens, Maria Magdalena, six specimens

183 *Strigatella tristis* Broderip Maria Madre, six specimens, Maria Magdalena, two specimens

184 *Strombina gibberula* Sowerby Maria Madre, about 100 specimens

185 *Strombina maculosa* Sowerby Maria Madre, six young specimens

186 *Strombina pulcherrima* Sowerby Maria Madre, three specimens

187 *Strombus galeatus* Wood (S) Maria Magdalena, several specimens

188 *Strombus granulatus* Gray Maria Madre, two young specimens, Maria Magdalena, one specimen

189 *Strombus peruvianus* Swainson Maria Magdalena, two specimens

190 *Tegula globula* Carpenter (S) Maria Madre, one specimen, Maria Magdalena, nine specimens

191 *Tegula mariana* Dall Maria Madre, 20 specimens, Maria Magdalena, 12 specimens This is *Omphalius coronatus* of Carpenter and Tryon, not Adams

192 *Thais biserialis* Blainville Maria Madre, two specimens, Maria Magdalena, one specimen

193 *Triphora contrerasi* Baker Maria Madre, 11 specimens

194 *Triphora dalli* Bartsch Maria Madre, 14 specimens

195 *Triphora peninsularis* Bartsch Maria Madre, 12 specimens

196 *Trivia pulla* Gaskoin Maria Madre, three specimens

197 *Trivia radians* Lamarck (S) Maria Magdalena, one specimen

198 *Trivia sanguinea* Gray Maria Magdalena, one specimen

199 *Turbo fluctuosum* Wood (S) Maria Madre, four specimens, Maria Magdalena, one specimen

200 *Turbo squamiger* Reeve (S) Maria Madre, 25 specimens, mostly young

201 *Turbonilla (Mormula) coyotensis* Baker, Hanna & Strong Maria Madre, two specimens

202. *Turbonilla (Pyrgiscus) flavescens* Carpenter Maria Madre, about 40 specimens

203 *Turbonilla (Pyrgiscus) indentata* Carpenter. Maria Madre, 25 specimens

204 *Turbonilla (Pyrgiscus) larunda* Dall & Bartsch Maria Madre, about 100 specimens

205 *Turbonilla (Chemnitzia) ? muricata* Carpenter, Maria Madre, two worn specimens

206 *Turbonilla (Pyrgiscus) ? sanctorum* Dall & Bartsch Maria Madre, one worn specimen

207 *Turricula tuberculifera* Broderip & Sowerby Maria Madre, eight specimens, young

208 *Turritella tigrina* Kiener Maria Magdalena, two specimens

209 *Typhis grandis* A. Adams Maria Madre, two specimens

210 *Vasum cæstus* Broderip Maria Magdalena, two specimens

211 *Williamia peltoides* Carpenter (N.) Maria Madre, two specimens

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL XIX, No 4, pp 23-40, plate 1, 4 text figs. JULY 15, 1930

IV

SOME RISSOID MOLLUSCA FROM THE GULF OF CALIFORNIA

BY
FRED BAKER
G D HANNA
AND
A M STRONG

This report has been prepared in the same manner as one on the Pyramidellidæ which we published in 1928.[1] The same collections there mentioned have furnished species of Rissoidæ; in addition, one fine large form was found in a small collection from Cape San Lucas, made by the naturalists of the U S S *Albatross* about 1914. This collection was deposited in the California Academy of Sciences and contains a considerable number of species, mostly large forms

The west American species which have generally been grouped together under Rissoidæ have been divided by Drs Dall and Bartsch into several genera and three families Of these the following appear in this paper *Alvania* and *Amphithalamus* in the family Rissoidæ, *Rissoma* in the family Rissoinidæ, and *Barleeia* and *Rissoella,* not ascribed to any family

The species are comparatively easy to identify because of the excellent monographic studies prepared by Dr Paul Bartsch and published by the U S National Museum An exception must be noted in the case of *Barleeia* The simple

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[1] Proc. Calif Acad Sci, ser 4, vol 17, no 7, pp 205-246, pls. 11, 12, June 29, 1928

nature of the shells of the species of this genus, and the lack of information as to ecology and limits of variation, cause the determinations to be somewhat questionable. We have recognized and illustrated four species but we are not completely convinced that the collections do not contain a greater, or possibly a lesser, number

1 **Alvania lucasana** Baker, Hanna & Strong, new species

Plate 1, figure 1

Shell rather small, everywhere marked by minute growth lines, cylindro-conic, dark straw-colored, nuclear whorls about two, smooth and slightly shining, depressed, forming a mammillate apex, post-nuclear whorls four, well rounded, narrowly, slopingly shouldered above, marked by rather indistinct, rounded, vertical or slightly retractive axial ribs, obsolescent on the base, about 22 appearing on the first whorl, 16 on the second, 18 on the third, and 24 on the last, interspaces and axial ribs crossed by nearly equal and equally spaced, narrow spiral cords, five appearing on the first and six on the succeeding turns, producing tubercles at their intersections with the axial ribs, these cords separated by very distinct, wavy incised spiral lines, the upper slightly more marked, giving the appearance of an appression of the summits of the whorls and bringing the upper row of tubercles into decided relief, sutures moderately impressed but rendered indistinct by the extensions of the axial ribs; periphery scarcely defined by the extension of the lowest suture; base rather long, well rounded, showing the feeble extensions of the axial ribs and about nine? nearly equal spiral cords, aperture entire, broadly subpyriform, the posterior angle being obtuse, outer lip not much thickened and the peritreme nowhere heavily calloused, probably because the holotype is not fully mature Length 2 5 mm , diameter 1 mm

Holotype No 4597, Mus Calif Acad Sci, collected by G D Hanna and E. K Jordan in 1925 at **Cape San Lucas, Lower California** Three additional specimens were taken at the same place.

This species most nearly resembles *Alvania compacta* Carpenter, from the region north of Puget Sound, but is more slender and has fewer axial ribs The great difference in distribution makes it improbable that it is even a subspecies.

2 **Alvania herreræ** Baker, Hanna & Strong, new species

Plate 1, figure 2

Shell small, ovate, slightly shining, light straw-colored, nuclear whorls about two, rather prominent, smooth, slightly opalescent, mammillate, postnuclear whorls four, rather straight above, rounded below, slightly overhanging, very narrowly tabulately shouldered at their summits, differentiated from the last nuclear whorl by a prominent tubercle, the first of a spiral series continuing on the periphery, most marked on the first two whorls and becoming obsolete on the body whorl, each tubercle forming the lower part of a narrow axial rib, about eight appearing on the first whorl, 14 on the second, and 16 on the third and fourth, intercostal spaces shallow, flattened at the bottom, about twice as wide as the axial ribs, crossed by subequal and subequally spaced, low, rounded spiral cords, sloping more abruptly above than below, those on the first two turns indistinctly marked, about 12 on the third and fourth whorls, these cross the axial ribs and render them tuberculate at their intersections, the upper two tend to become fused, thus producing a more prominent series of tubercles indistinctly coronating the whorls, a similar fusing appears at places on the lower two cords connecting the peripheral series of tubercles, upper sutures strongly impressed, the last only slightly so; base rather long, defined by a shallow sulcus, the continuation of the last suture, marked by feeble continuations of the axial ribs and by about 12 equal and equally spaced cords similar to those on the body whorl, beginning rather close together near the aperture and separating regularly as they advance, aperture broadly and quite regularly pyriform, rendered entire by a callus which is most marked on the outer lip; outer lip thickened on the edge, thin within, showing the external sculpture clearly Length 3 mm , diameter 1.5 mm.

Holotype No. 4598, Mus. Calif Acad Sci., collected by G D. Hanna and E K Jordan in 1925 at **Cape San Lucas,**

Lower California. About 20 additional specimens were taken at the same place.

This species can be differentiated from *Alvania lirata* (Carpenter)[8] by its less defined sutures and narrower axial ribs, especially just above the sutures where *A lirata* shows greatly enlarged tubercles, and by the subcoronation of the whorls. It is perhaps more like *Alvania lucasana* of this paper but it is more obese, has fewer axial ribs and has differently shaped whorls

The species is named for Prof A Herrera, Director of Biological Studies in Mexico

3 **Alvania gallegosi** Baker, Hanna & Strong, new species

Plate 1, figure 11

Shell rather small, elongate-conic, everywhere marked by minute growth lines, covered by a thin, fugaceous, light straw-colored epidermis, showing white where denuded, nuclear whorls nearly two, smooth, well rounded, forming a mammillated apex, postnuclear whorls 5⅛, subangulated at the periphery, cancellated by narrow, rounded, slightly protractive axial ribs terminating at the suture of the last whorl, and nearly equal spiral cords, generally tuberculated at their intersections and enclosing shallow, squarish pits, from 20 to 22 axial ribs appear on all whorls except the first, four spiral cords appear on the lower whorls, the first three placed on a long, sloping shoulder occupying about ⅗ of each whorl, the fourth cord forming the narrow carina of the subangulation; spiral cords subequal and subequally spaced, the upper two being slightly closer than the others, the posterior at the summit, just outside the suture, the anterior almost equally near the lower suture, the last whorl and base showing fine, intercalating, spiral cords, sutures deeply impressed; base rather short, slightly inflated at the periphery, marked by nine low, rounded roughened, but scarcely tuberculate spiral cords, the upper originating in the last suture, the others on the parietal wall and spreading and diminishing rather evenly towards the um-

[8] *Rissoa lirata* Carpenter, Cat. Maz Shells, 1856, p 358, *Alvania lirata* Bartsch, Proc U S. Nat. Mus., vol 41, p 338, pl 29, fig 3, 1911

bilical region, aperture very broadly and rather evenly pyriform, outer and basal lips very thin, crenulated by the external sculpture which shows plainly within, columella and parietal wall scarcely calloused. Length 2 3 mm., diameter 1.1 mm

Holotype No 4599, Mus Calif Acad Sci, collected by G. D Hanna and E K. Jordan in 1925 at **Cape San Lucas, Lower California.** Two additional specimens were taken at the same place

This species differs from other west American Alvanias by its subangulated periphery, this character is noticed in *A lara*[3] from the Galapagos Islands, but in that species the spiral cords are sublaminate and differently arranged

The species is named for Professor José Maria Gallegos of the Mexican Biological Survey who lost his life in Yucatan in the prosecution of his work and who is much honored in California for his untiring efforts to bring about a coordination of the biological work of the Federal Government of Mexico with similar work being carried on in the State of California

4 **Alvania monserratensis** Baker, Hanna & Strong, new species

Plate 1, figure 9

Shell very small, subperforate, oblong-ovate, white or more or less clouded with straw-color or brown, nuclear whorls small, immersed and scarcely showing, postnuclear whorls four, decidedly exserted, with a broad, sloping shoulder above, convex below, cancellated by subequal and subequally-spaced, rather prominent, narrow, slightly retractive axial ribs terminating on the last whorl, and lower, subequal spiral cords, forming rather deep, squarish pits, generally longer in a spiral direction with the tubercles at their intersections, about 20 axial ribs appearing on the second turn, 22 on the third and 26 on the last, with four spiral cords on the last three whorls, the first in the middle of the shoulder, the second at the angle, the other two about equally spaced between this and the suture, sutures deeply impressed, crossed by the axial ribs, base slightly concave at the umbilical region, well rounded behind, marked by four subequal and subequally spaced spiral cords separated from the last cord by a continuation of the

[3]*Alvania lara* Bartsch, Proc U S Nat Mus., vol 41 1911, p 357, pl. 32, fig 6.

suture, the posterior two being distinctly tuberculate, aperture entire, subcircular, calloused throughout; outer lip indistinctly dentate within, showing the external sculpture behind the thickened edge Length 1.35 mm, diameter 0.75 mm

Holotype No. 4600, Mus Calif Acad Sci, collected by Fred Baker in 1921 at **Monserrate Island, Gulf of California.** Three specimens were taken at Amortajada Bay, San Jose Island, Gulf of California, one at Coyote Bay, Concepcion Bay, Lower California, several others were taken at Cape San Lucas Some of the Cape San Lucas specimens are light brown throughout while others show a broad yellowish blotch behind the external labial varix

The species more closely resembles *Alvania oldroydæ* Bartsch[4] than any other described from the west coast but it is thinner, smaller, more slender, has a much broader shoulder, flatter whorls and a different arrangement of the spiral cords on the postnuclear whorls and base; it also lacks the wide umbilicus of *A oldroydæ*

5 **Alvania albolirata** (Carpenter)

Rissoa albolirata Carpenter, Ann Mag Nat Hist, ser 3, vol 13, 1864, p 76
Alvania albolirata (Carpenter), Bartsch, Proc U S Nat. Mus, vol 41, 1911, p 338, pl. 29, fig 6

A single shell taken at Sal si Puedes Island, Gulf of California, agrees well with Bartsch's description and figure of this species. It is slightly broader and the aperture varies somewhat, probably due to immaturity

6 **Alvania lirata** (Carpenter)

? *Rissoa lirata* Carpenter, Cat Maz Shells, 1856, p 358
Alvania lirata (Carpenter), Bartsch, Proc U S Nat Mus, vol. 41, 1911, p 338, pl 29, fig. 3
Rissoa porteri Dall, ms, 1909

Specimens of this species were taken in five fathoms off the Salt Works, San Jose Island, at Ballandra Bay, Carmen Island; at Isthmus Bay, Espiritu Santo Island; on Monserrate Island, and at Isla Partida in the Gulf of California. It was

[4] Bartsch, Proc. U S. Nat Mus., vol 41, 1911, p. 360, pl. 32, fig 3

also taken at Cape San Luças, Agua Verde Bay, Puerto Escondido, and San Francisquito Bay, Lower California. Besides these there is in the Baker collection a large number of specimens taken by George D Porter in the "Gulf of California," and these constitute the type lot of *Rissoa porteri* Dall, ms , these shells are identical with *Alvania lirata* (Carpenter) So far as we are able to learn, Dr Dall never validated this name, but unfortunately, the species has been rather widely distributed as *Rissoa porteri*

7 **Alvania electrina** (Carpenter)

? *Diala electrina* CARPENTER, Ann Mag Nat Hist , ser 3, vol 3, 1864, p 478
Alvania electrina (CARPENTER), BARTSCH, Proc U S Nat Mus , vol 41, 1911, p 346, pl 30, fig 4

About 50 specimens of this species were taken at Cape San Lucas Some are almost typical while others vary widely in the number of spiral cords on the various whorls and the base, generally with an increase in the numbers As high as 12 were counted on the penultimate turn and nine on the base There is also considerable variation in the strength of the axial ribs but no great variation in their number The intergradations are fully represented

8 **Alvania æquisculpta** Keep

Alvania æquisculpta KEEP, West Coast Shells, ed 1, 1887, p 65
Rissoa (Alvania) grippiana DALL, Nautilus, vol 21, 1908, p 136

Two mature specimens taken at Cape San Lucas, Lower California, undoubtedly are this species The southern limit of the range previously reported was San Martin Island, Lower California.

9 **Alvania tumida** Carpenter

Alvania tumida CARPENTER, Cat Maz. Shells, 1856, p 360 —BARTSCH, Proc U S Nat Mus , vol 41, 1911, p 361, pl 32, fig 2

Several dozen specimens of this species were taken at Cape San Lucas, Lower California They show only slight variation in the number of spiral cords and axial ribs

10 **Rissoina porteri** Baker, Hanna & Strong, new species

Plate 1, figure 15

Shell very small, slender, elongate-conic, distinctly curved, shining translucent, white, nuclear whorls four, the first mammillate, the others only slightly convex, forming a very regular cone and showing a very minute and irregular thimble-pitting in places, change to post-nuclear whorls not well-defined, the last nuclear whorl appearing to be slightly imbedded in the first postnuclear turn, postnuclear whorls 4½, the upper ones broadly, not quite tabulately shouldered above, the last two more slopingly, rather strongly curved below and somewhat appressed at the sutures, marked by narrow, sublamellate, sinuous, irregular and irregularly placed, strongly protractive axial ribs extending without diminution to the columellar and basal fasciole, about 10 appear on the first whorl, 12 on the remaining turns, intercostal spaces wider than the axial ribs, rather deep and rounded below, showing no definite sculpture, sutures deep but not well defined, base rather long, marked by a fasciole which is an extension of the very heavy columellar callus and which shows on its edge a minute tubercle at the lower extremity of each axial rib scarcely discernible at the magnification of the figure, aperture broadly sublunate, outer and basal lips much thickened, the outer showing a few broad lirations on the inner, upper portion, columella and adjacent portion of the inner lip very heavily calloused and reflected adnately to form the basal fasciole, parietal wall heavily, but more narrowly calloused Length 2 35 mm diameter 0 85 mm

Holotype No 4601, Mus Calif Acad Sci, collected in the "**Gulf of California**" by George D Porter, for whom the species is named Five additional specimens from the same lot are in the Baker collection

The species has very marked resemblances to, and differences from, *Rissoina signæ* Bartsch[5] Its nucleus is very large and prominent instead of depressed; it lacks the spiral striations on the intercostal spaces, is more narrowly and less tabulately shouldered, and is more slender, but the arrangement of the axial ribs and intercostal spaces is very similar

[5] Proc U S Nat Mus. vol 49, 1915, p 61, pl 31, figs. 1, 4.

11. **Rissoina melanelloides** Baker, Hanna and Strong, new species

Plate 1, figure 5

Shell rather small, quite evenly elongate-conic, everywhere marked by minute, protractive growth lines which are enlarged at irregular intervals giving the appearance of obscure axial ribbing, also by many microscopic spiral lines, shining, milk-white, nuclear whorls about 1½, smooth, the first portion depressed and evenly rounded, the latter portion very convex, postnuclear whorls 6½, nearly straight above, more rounded on the anterior third, the first differentiated from the last nuclear whorl only by the beginning of a narrow, shallow, impressed spiral line anteriorly towards the suture, a second appearing a little later on the turn, these increasing by rather evenly placed additions until about five appear on the third whorl, seven on the fourth and fifth, and 12 on the last, these incised spiral lines indistinctly define very low, nearly equal, rounded spiral cords which continue quite regularly over the whole shell, becoming obsolescent on the base, sutures shallow, not much more clearly defined than the impressed spiral lines, base rather long, evenly rounded, marked by the obsolescent extensions of the spiral cords, aperture entire, very oblique, quite regularly pyriform but slightly flattened on the columellar side, outer and basal lips slightly thickened, straight above, curving to form almost an exact segment of a circle below, joining the columella without marked change, columella scarcely thickened or reflected, defining a distinct umbilical depression, parietal wall with a very narrow, thin callus Length 3 30 mm , diameter 1 40 mm

Holotype No 4602, Mus Calif Acad Sci, collected by G D Hanna and E K Jordan in 1925 at **Cape San Lucas, Lower California** Five additional specimens were taken at the same place

The shape of the species suggests a *Melanella* It is perhaps more like *Rissoina dalli* Bartsch[9] from the California coast than any other west American species, but it is larger, has less convex whorls, less distinct sutures, and is sharply differentiated by the spiral sculpture

[9]Bartsch, Proc U S Nat Mus., vol. 49, 1915, p. 59, pl 33, fig 2

12 **Rissoina gisna basilirata** Baker, Hanna & Strong, new subspecies

Plate 1, figure 12

The form closely resembles *Rissoina gisna* Bartsch[1] It seems to be immature, showing one less whorl than the type and a thin outer lip, but has the aperture and base of the columella as noted by Bartsch, about the same number and arrangement of axial ribs, but lacks the spiral sculpture everywhere except on the base where there are about 25 basal cords instead of 11 Bartsch's figure shows decided weakening of the spiral sculpture above the periphery, but it is everywhere present except on the nuclear whorls The variation is sufficiently marked to indicate a probable distinct race

Holotype. No 4606, Mus Calif. Acad Sci, collected by Fred Baker in 1921 at the **West Anchorage, San Jose Island, Gulf of California.**

13 **Rissoina firmata** (C. B. Adams)

Rissoa firmata C B Adams, Ann Lyc Nat Hist N Y, vol 5, 1852, p 401
Rissoa scalariformis C B Adams, op cit, p 402
Rissoina firmata (C B. Adams), Bartsch, Proc U S Nat Mus, vol 49, 1915 p 38, pl 32, figs. 4, 6

Specimens of this species were taken at Cape San Lucas, Puerto Escondido and Coyote Bay, Concepcion Bay, Lower California, and at the West Anchorage, San Jose Island, Gulf of California

14 **Rissoina stricta** Menke

Rissoina stricta Menke, Zeitschr. f Malak, 1850, p 177, no 37 —Bartsch Proc U S Nat. Mus, vol 49, 1915, p 39, pl 28, fig 6

Specimens of this well-marked species were taken at Tepoca Bay, Sonora, Puerto Escondido, Lower California, and on Sal si Puedes, San Esteban, Georges, Isla Partida, Isla Raza, and Santa Cruz islands, Gulf of California.

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[1]Bartsch, Proc U S. Nat Mus., vol. 49, 1915, p 41, pl. 28, fig 1

15 Rissoina nereina Bartsch

Rissoina nereina BARTSCH, Proc U S Nat Mus vol 49, 1915 p 53, pl 32, fig 1

Specimens of this species were taken at Cape San Lucas, La Paz, Coyote Bay, Concepcion Bay and San Francisquito Bay, Lower California, and at the Salt Work, Carmen Island, Isthmus Bay, Espiritu Santo Island, Amortajada Bay, San Jose Island, and at Monserrate Island, Gulf of California

16 Rissoina bakeri Bartsch

Rissoina bakeri BARTSCH Proc U S Nat Mus, vol 49, 1915, p 56, fig 4

A single shell, not quite mature, taken at Cape San Lucas Lower California, seems to agree with Bartsch's figure and description Dr Bartsch has reported the species from Monterey, California, to South Coronado Island off the northern coast of Lower California Specimens identified by him were taken by Baker on San Martin Island, 200 miles farther south, so that an extension to Cape San Lucas seems very probable However, as our shell is immature, this extension of range may be taken with some doubt

17 Rissoina stephensae Baker, Hanna & Strong, new species

Plate 1, figure 14

Shell small, everywhere marked by rather distinct, slightly retractive growth lines, elongate-conic, dark chestnut brown irregularly flamed with whitish near the sutures, nuclear whorls nearly two, depressed, mammillated, smooth, lighter than the rest of the shell, indistinctly differentiated from the succeeding turns, post-nuclear whorls nearly seven, very moderately and evenly rounded, everywhere marked by rather prominent, nearly equal and equally spaced spiral cords separated by narrow, distinct impressed spiral sulci, of which four appear on the first three whorls and eight on the penultimate; also by very low, indistinct axial undulations of which about six appear on the earlier whorls and about 10 on the last; these are too low to be classed as axial ribs and failed to

appear in our photograph, subsutural spiral cord slightly wider and flatter than the succeeding ones, marked by irregularly spaced brown spots not uniform in size, separated by irregularly triangular whitish flames extending downward over two or three spiral cords, this subsutural cord becomes the peripheral cord on the last turn; periphery subangulate near the aperture, base rather short, marked below the peripheral cord by six spiral cords, the upper ones about equal to those preceding them, but gradually diminishing towards the umbilical region, aperture quite regularly oval, with a rounded posterior canal, only slightly effuse near the base of the columella, outer and basal lips thin, scarcely thickened within, the basal lip very slightly reflected, columella very concave, narrowly reflected, free below, closely appressed above, narrowly calloused, the callus disappearing within the aperture, parietal wall free from callus Length 4 mm, diameter 1 5 mm

Holotype No 4607, Mus Calif Acad Sci, collected by G D Hanna and E K Jordan in 1925 at **Cape San Lucas, Lower California** Seven additional specimens were taken at the same place

This species falls into a very distinct group represented on this coast by four species characterized by color markings, thin outer lip, and the spiral sculpture predominating over the ill-defined or obsolete axial undulations The opercula of the three gulf species, *Rissoina lapazana* Bartsch,[8] *R berryi*, and *R stephensæ*, are unknown However, that of the fourth species, *R kelseyi* Dall & Bartsch,[9] from southern California, is found to be typical of the genus as is shown by the accompanying figures 6 and 7 *R stephensæ* differs from the other species in the group in color, in being much smaller for an equal number of whorls, in having slightly fewer axial undulations and spiral cords, especially on the base, and in other details There is some variation in the number of spiral cords on the postnuclear whorls of the topotypes but within very narrow limits

[8] Bartsch, Proc U S. Nat. Mus., vol. 49, 1915, p 50, pl. 30, fig 6.

[9] Dall & Bartsch, Nautilus, vol 16, 1902, p. 94, Proc U S. Nat Mus., vol. 49, 1915, p. 49 pl. 30, fig 4

The species is named for Mrs Kate Stephens, Curator of Mollusks in the San Diego Society of Natural History

18 **Rissoina berryi** Baker, Hanna & Strong, new species

Plate 1, figure 3

Shell large, broadly elongate-conic, everywhere marked by distinct and strongly protractive growth lines, shining white, nuclear whorls about two, smooth, the first depressed, the second prominent, not distinctly differentiated from the postnuclear turns; postnuclear whorls 6½, rather convex narrowly shouldered above, the first two nearly smooth but showing the beginning of faint opaque, slightly colored axial markings which become stronger below and are discernible in the umbilical region, numbering about 20 in the lower whorls, these appear under certain lighting as faint ribs but are not raised above the general surface, spiral sculpture consisting of low rounded spiral cords uneven in size, separated by narrower impressed spiral sulci beginning on the third postnuclear turn, increasing in number on each succeeding turn and extending over the base, of which about four appear on the fourth, 10 on the penultimate turn, and 10 on the base periphery not distinctly marked, base rather short, evenly rounded behind, slightly concave in the umbilical region, aperture subovate, slightly effuse near the columellar base, roundly angulate above, outer and basal lips somewhat worn but apparently thickened within, columella very concave, narrow above, rather broad and flattened below, backed by a very narrow fasciole, parietal wall marked by the beginnings of the basal spiral cords, scarcely calloused. Length 9 mm, diameter 3 75 A more worn but larger specimen measures length 9 5 mm, diameter 4 25 mm

Holotype No 4608, Mus Calif Acad Sci, collected by E C Johnson of the U S S *Albatross* about 1914, **Cape San Lucas, Lower California** Three additional specimens were taken at the same place

The species falls into the group mentioned under *R. stephensæ* of this paper It is much the largest of the group and much more obese; it also has more axial ribs than any of

the other species of the group. The species is named for Dr S Stillman Berry, one of the outstanding malacologists of this coast

19 Rissoina woodwardii Carpenter

Plate 1, figure 8

Rissoina woodwardii Carpenter, Cat Maz Shells, 1856, p 357 —Bartsch, Proc U S Nat Mus, vol 49, 1915, p 57

One specimen was taken in San Luis Gonzaga Bay and two in Isthmus Cove, Espiritu Santo Island, Gulf of California

20 Rissoella tumens (Carpenter)

Plate 1, figure 13

Jeffreysia tumens Carpenter, Cat Maz Shells, 1856, p 363
Rissoella tumens (Carpenter), Bartsch, Proc U S Nat Mus, vol 58, 1920 (1921), pp 160, 161, pl. 12, fig 1

About a dozen specimens were taken at Cape San Lucas, Lower California A few of the younger shells contain the operculum and agree with Carpenter's description and dimensions An adult example has six whorls and measures length 4 3 mm, diameter 2 9 mm

21 Rissoella excolpa Bartsch

Plate 1, figure 10

Rissoella excolpa Bartsch, Proc U S Nat Mus, vol 58, 1920 (1921), p 161, pl 12, fig 3

About 100 specimens were taken at Cape San Lucas, Lower California, many of which show faint color banding

22 Rissoella johnstoni Baker, Hanna & Strong, new species

Plate 1, figure 16

Shell small, thin, translucent, shining, white, everywhere marked by indistinct, slightly retractive growth lines; nuclear whorls nearly two, the first rather flatly mammilate, the second roundly shouldered above, rather straight below, smooth,

postnuclear whorls 2½, roundly shouldered above, well rounded below, everywhere marked by unequal and unequally spaced, low narrow spiral cords extending to the edge of the open umbilicus about 9 appearing on the first, 12 on the second and not less than 25 on the base and final turn, periphery well rounded, base rather long and well rounded, umbilicus elongate-lunate, rather large and open, sutures distinctly impressed, aperture oval, outer and basal lips thin, the latter effuse near the columellar junction, columella convex, heavily calloused but scarcely reflected over the umbilicus, parietal wall showing the continuation of the callus flatly adanate above the umbilicus, rendering the aperture entire Length 1 6 mm , diameter 1 0 mm A weathered specimen measures length 1 7 mm , diameter 1 1 mm

Holotype No 4612, Mus Calif Acad Sci, collected by G D Hanna and E K Jordan in 1925 at **Cape San Lucas, Lower California** Two additional specimens were taken at the same place

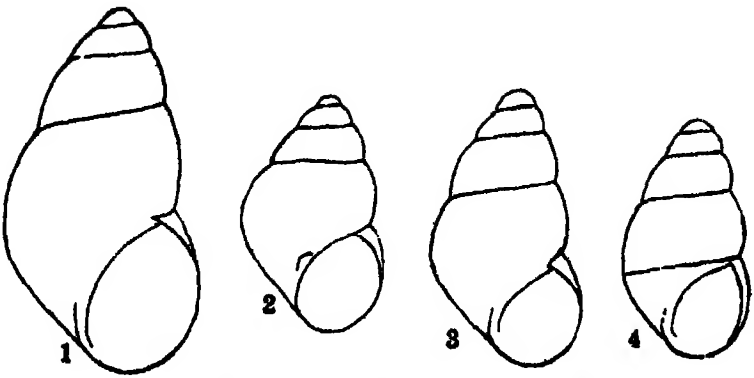
The species somewhat resembles *R tumens* (Carpenter), but differs from this species by its small size and from all west coast species in the well-marked spiral cords

It is named for Mr Edward C Johnston, Naturalist of the U S S *Albatross* at the time a Cape San Lucas collection of shells was made

23 **Amphithalamus inclusus** Carpenter

Amphithalamus inclusus CARPENTER, Ann Mag Nat Hist , ser 3, vol 15, 1865, p 181 —BARTSCH, Proc U S Nat Mus , vol 41, 1911 (1912), p 264, text fig 2

A single specimen was taken at Monserrate Island, Gulf of California, and several at Cape San Lucas, Lower California The species has not previously been reported below San Diego, California



Outline, camera lucida figures (X25) of *Barleeia* from Cape San Lucas, Lower California

Fig 1 *Barleeia subtenuis* Carpenter Plesiotype, No 4613 (C A S) Length 2 4 mm
Fig 2 *Barleeia orcutti* Bartsch Plesiotype, No 4614 (C A S)
Fig 3 *Barleeia alderi* Carpenter Plesiotype, No 4615 (C A S)
Fig 4 *Barleeia bentleyi* Bartsch Plesiotype, No 4616 (C A S)

24 Barleeia alderi (Carpenter)

Text figure 3

Jeffreysia alderi Carpenter, Cat Maz Shells, 1856, p 362
Barleeia alderi (Carpenter), Bartsch, Proc U S Nat Mus , vol 58, 1920 (1921), p 175, pl 12, fig 6

Five specimens were taken at the Northeast Anchorage, Monserrate Island, Gulf of California, and a large series at Cape San Lucas, Lower California Many of the latter show little or no sign of color banding

25 Barleeia subtenuis Carpenter

Text figure 1

Hydrobia ulvae (Pennant) Carpenter, Cat Maz Shells, 1856, p 361, an error in diagnosis
Barleeia subtenuis Carpenter, Suppl Rep Brit Assoc Adv Sci , 1864, pp 546, 625, 656, 669 —Carpenter, Jour de Conch , vol 13, 1865, pp 143, 144 —Bartsch, Proc U S Nat Mus , vol 58, 1920 (1921), pp 169, 170, pl 13, fig 11

One specimen was taken at Sal si Puedes Island, several at Monserrate Island, Gulf of California, one at San Luis Gon-

zaga Bay, about a dozen at Cape San Luca, and several hundred on "sea lettuce" in San Francisquito Bay, Lower California Five specimens in the Baker collection were taken in the "Gulf of California" by George D Porter, three of them being much larger than those noted above The largest measures: length 3 6 mm, this being larger than any we have seen reported

26 Barleeia bentleyi Bartsch

Text figure 4

Barleeia bentleyi BARTSCH, Proc U S Nat Mus, vol 58, 1920 (1921), pp 168, 169, pl 13, fig 2

Of several dozen specimens taken at Cape San Lucas, Lower California, a few agree in every way with the description and figure, though the majority are of a darker shade of brown, none being quite fully mature This extends the range from the type locality, Venice, California, to the southern end of Lower California

27 Barleeia orcutti Bartsch

Text figure 2

Barleeia orcutti BARTSCH, Proc U S Nat Mus, vol 58, 1920 (1921), p 174, pl 13, fig 8

Three specimens taken at Northeast Anchorage, Monserrate Island, Gulf of California, agree with the description and figure of this species the type locality of which is Magdalena Bay on the opposite side of Lower California

July 15 1930

PLATE 1

Fig. 1. *Alvania lucasana* Baker, Hanna & Strong, n. sp Holotype, No. 4597 (C. A. S.), from Cape San Lucas, Lower Calif., length 2.5 mm , p 24

Fig 2 *Alvania herrerae* Baker, Hanna & Strong, n sp Holotype, No 4598 (C A S), from Cape San Lucas, Lower Calif ; length 3 0 mm , p 25

Fig. 3 *Rissoina berryi* Baker, Hanna & Strong, n sp Holotype, No 4608 (C A S), from Cape San Lucas, Lower Calif , length 9 mm , p 35

Fig. 4 *Rissoina kelseyi* Dall & Bartsch Plesiotype, No 4603 (C A S), from Coronado Islands, Lower Calif , length 5 8 mm., p 34

Fig 5 *Rissoina mellonelloides* Baker, Hanna & Strong, n sp Holotype, No 4602 (C A S), from Cape San Lucas, Lower Calif ; length 3 30 mm , p 31

Fig. 6 *Rissoina kelseyi* Dall & Bartsch Plesiotype, No. 4604 (C A. S.), from Coronado Islands, Lower Calif , length of operculum about 1 0 mm., p. 34

Fig. 7 *Rissoina kelseyi* Dall & Bartsch Plesiotype, No 4605 (C A S), from Coronado Islands, Lower Calif., length of operculum about 1 0 mm.; p 34

Fig 8 *Rissoina woodwardii* Carpenter Plesiotype No 4609 (C A S), from San Luis Gonzaga Bay, Lower Calif , length 3 0 mm , p 36

Fig. 9 *Alvania monserratensis* Baker, Hanna & Strong, n sp Holotype, No 4600 (C. A. S), from Monserrate Island, Gulf of Calif , length 1 35 mm , p 27

Fig 10. *Rissoella excolpa* Bartsch Plesiotype, No 4611 (C A S), from Cape San Lucas, Lower Calif.; length 1.4 mm , p 36

Fig 11 *Alvania gallegosi* Baker, Hanna & Strong, n sp Holotype, No 4599 (C A S.), from Cape San Lucas, Lower Calif , length 2 3 mm , p 26.

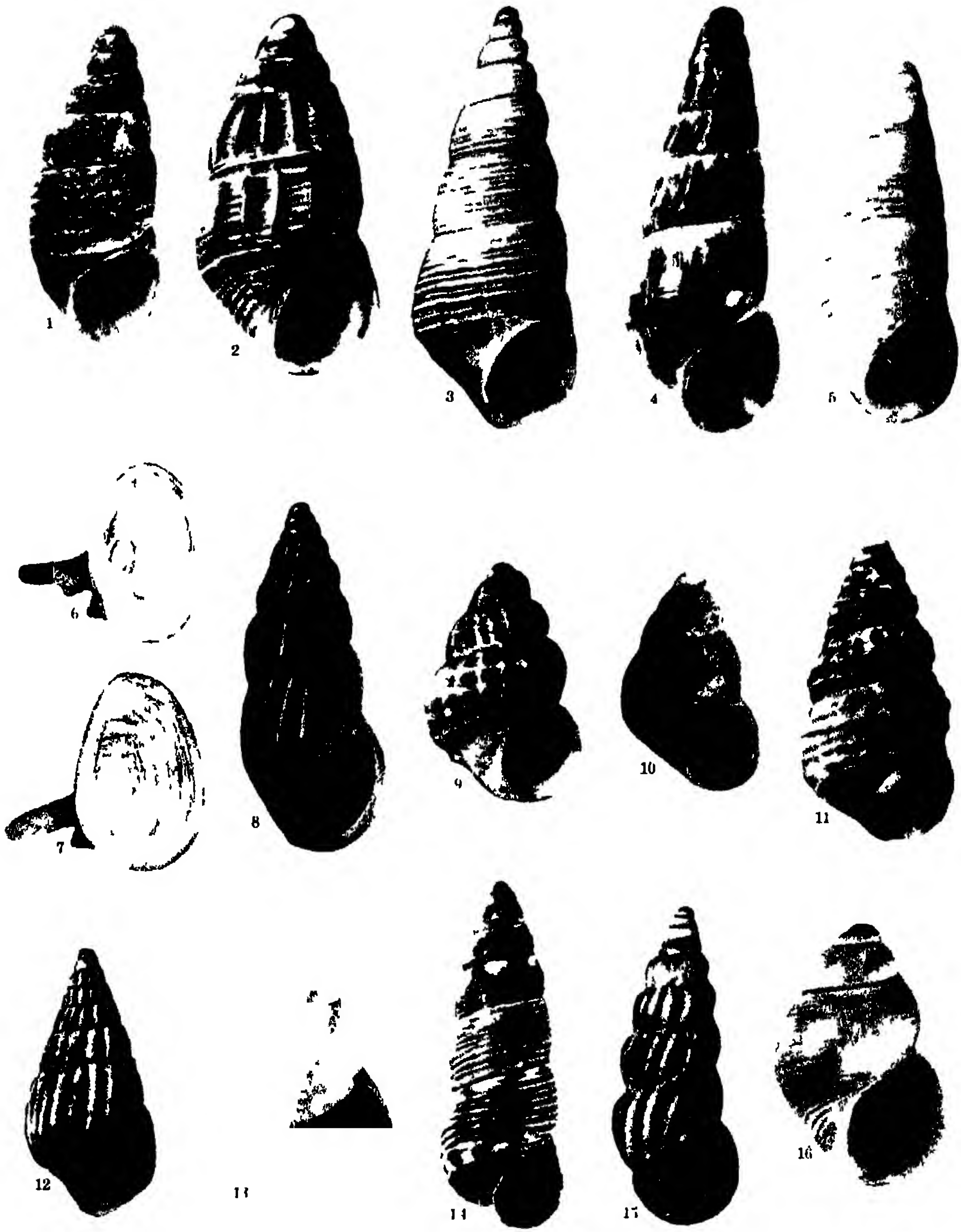
Fig 12. *Rissoina gisna basilirata* Baker, Hanna & Strong, n sp. Holotype, No. 4606 (C. A. S.), from West Anchorage, San Jose Island, Gulf of Calif., length 3.8 mm.; p 32

Fig 13 *Rissoella tumens* (Carpenter) Plesiotype, No 4610 (C A. S), from Cape San Lucas, Lower Calif ; length 4.0 mm , p 36

Fig 14 *Rissoina stephensae* Baker, Hanna & Strong, n sp Holotype, No 4607 (C. A S), from Cape San Lucas, Lower Calif , length 4 mm ; p. 33

Fig 15 *Rissoina porteri* Baker, Hanna & Strong, n. sp. Holotype, No 4601 (C A. S.), from Gulf of Calif., length 2.35 mm , p 30

Fig 16 *Rissoella johnstoni* Baker, Hanna & Strong, n sp Holotype, No 4612 (C A. S), from Cape San Lucas, Lower Calif.; length 1 6 mm , p 36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PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL XIX, No 5, pp 41-56, plates 2 and 3 JULY 15, 1930

V

SOME MOLLUSCA OF THE FAMILY EPITONIIDÆ FROM THE GULF OF CALIFORNIA

BY

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G D HANNA

AND

A M STRONG

This report constitutes another record of the 1921 Expedition of the California Academy of Sciences to the Gulf of California [1] In addition to the large number of stations at which collections were made during that year there have been included such members of this family as were obtained at Cape San Lucas, Lower California in 1925 [2]

The number of species credited to the family Epitoniidæ (=Scalaridæ) is very large, but they are all generally considered to belong to a single genus This genus, *Epitonium (=Scalaria)*, has been divided into a correspondingly large number of subgenera, some of which are very distinct while others are based on trivial differences California is credited with about 35 species in the genus, and an additional 25 have been described from Lower California and the Gulf of Cali-

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[1] For a general account of the expedition of 1921, see Slevin, Proc Calif Acad Sci., ser 4, vol. 12, no 6, pp 55-72, June 2, 1923

[2] For a general account of the expedition in 1925, see Hanna, Proc Calif Acad Sci, ser 4, vol. 15, no 1, pp 1-113, pls. 1-10, text figs. 1-7, March 30, 1926

fornia Many of these are known only from a single collecting, and sufficient material for a determination of the limits of specific variation is available only in a few cases Many of the recorded ranges are based on old identifications and records which are badly in need of verification The Academy's Gulf of California material in the genus is not sufficiently extensive to make any attempt at a general review of the entire fauna possible The following key to the subgenera known from the west coast shows the arrangement used in this paper and indicates the closely related groups of species with which comparison should be made

Key to Subgenera of West American Epitoniidæ

Shell with a Basal Disk Bounded by a Keel	
Surface with a spongy, punctate outer layer	
Varices faint over whorls, pointed in the sutures	Nodiscala
Varices strong over entire surface of whorls	Cirsotrema
Surface with a thin, chalky outer layer	
Varices partly obsolete, sutures pitted	Dentiscala
Surface without a distinct outer layer	
Spiral sculpture distinct	
Shell white	
Varices terminating at basal keel	Punctiscala
Varices extending to umbilical region	Boreoscala
Shell yellow or brown	
Sculpture evenly reticulated	Ferminoscala
Occasional ribs strongly varicose	Pictoscala
Spiral sculpture very fine or wanting	
Axial ribs strong and thick	Opalia
Shell Without a Basal Disk	
Spiral sculpture distinct	
Varices forming a ridged fold bounding the umbilicus	Crisposcala
Varices rounding into umbilical region	Asperiscala
Spiral sculpture very fine or wanting	
Shell distinctly banded with brown	Hirtoscala
Shell white	
Shell slender, turrited	Nitidiscala
Shell short and broad	
Varices thin and erect	Globoscala
Varices thick and reflexed	Sthenorytis

We have used the term "varix" with full knowledge that the axial ribs in the members of the family are not equivalent to true rest stages in some other genera. However, the word has been so generally applied to these structures in conchological literature that we believe no good purpose would here be served in abandoning it.

Very few of the west American species have been adequately illustrated and this omission has added enormously to the labor of identification. In order to correct matters as best we can we have illustrated all of the species identified in the present collection. In many cases the only information the student has available is a very generalized description in which actual diagnostic characters are not mentioned or if mentioned are not emphasized. Naturally, working from such literature, errors may be made which cannot be corrected until type material is consulted, redescribed or illustrated. Of the 12 species treated in the following pages three are believed to be new, the other nine seem to fall into described species which have not heretofore been illustrated.

In using the obscure name *Epitonium* "Bolten" Roding for the genus we have followed current west American usage without, however, subscribing to the propriety or legality of the adoption of Boltenian names in general.

Genus **Epitonium** "Bolten" Roding, 1798

Epitonium "Bolten" Roding, Mus. Boltenianum, 1798, p. 91

Subgenus **Nodiscala** de Boury, 1889

The species from the west coast which are placed in the subgenus *Nodiscala* form a distinct group, very different from the remainder of the Epitoniums. Dall[8] described the subgenus as follows: "These are small, slender imperforate shells with ill-defined axial nodes or ribs but only one true varix, which is terminal and much thickened. The shells when in good condition have a soft calcareous outer coat which is punctate or minutely sculptured." To this it can be added that the more

[8]Proc. U. S. Nat. Mus. vol. 53, 1917, p. 474

or less ill-defined ribs end in prominent points which coronate the sutures

In addition to the species described below the subgenus contains the following from the west coast. *Epitonium spongiosum* (Carpenter),[4] described from Monterey with eight undulated ribs, *Epitonium mazatlanicum* (Dall),[5] described from Mazatlan, with 20 faint ribs, and *Epitonium mexicanum* (Dall),[6] from Acapulco, with nine wide ribs All three are known only from the type localities

1 **Epitonium (Nodiscala) golischi** Baker, Hanna & Strong, new species

Plate 2, figures 1, 2

Shell rather large for the subgenus, with the characteristic calcareous outer coat, dull cream-white, nuclear whorls very small, depressed helicoid, about one and a half, the first nearly smooth, the second showing the faint beginnings of varices, not sharply differentiated from the succeeding turn, postnuclear whorls about eight, high between the sutures, very moderately and evenly rounded, with ten broad, low-rounded, slightly retractive varices, obsolete on the lower whorls, more distinct on the upper turns, terminating posteriorly in broad, rounded points coronating the whorls, appressed to the preceding whorls and separated by rather deep depressions extending into the sutures, interspaces about as wide as the varices on the lower whorls, proportionally wider above, all postnuclear whorls marked by very indistinct, low rounded axial riblets, parallel to, and extending over the varices, crossed by equally indistinct spiral cords, both groups being further marked throughout by quite distinct, irregular and irregularly spaced, microscopic vertical riblets crossed by equally fine spiral cords separated by minute, incised, punctate spiral lines, the punctations unequal, generally circular, rather deep, and placed at the intersections of the interspaces of the vertical riblets, sutures rather deep, obscured by the coronating varices, base rounded above, concave below a basal disk

[4] Proc Calif Acad Sci, ser 1, vol 3, 1865, p 222
[5] Proc U S Nat Mus, vol 34 1908 p 250
[6] Op cit, p 251

defined by an extension of the last suture as a depressed line with a series of broad holes corresponding to those on the upper sutures and a second series of holes half way from the basal disk to the anterior extremity of the shell, aperture broadly subpyriform, distinctly effuse below, outer lip rather thin, basal lip and parietal wall heavily calloused Length, 13 mm , diameter, 5 8 mm

Holotype No 4770, Mus Calif Acad Sci, from **San Francisco Island, Gulf of California,** and a half-grown paratype (No 4771), from Puerto Escondido, Lower California, both collected by Fred Baker in 1921 The holotype is probably not quite mature as it lacks the "much thickened" terminal varix noted by Dall[7] as characteristic of the subgenus

Besides other distinguishing criteria, this species differs from all others of the subgenus described from this coast in being much more obese

It is named for the late W H Golisch, one of our most enthusiastic west coast conchologists

2 Epitonium (Nodiscala) retiporosum (Carpenter)

Plate 2, figure 3

Opalia retiporosa Carpenter, Suppl Rep Brit Assoc Adv Sci, 1864, p 660 Proc Calif Acad Sci, vol 3, 1865, p 222

One immature example was taken at Cape San Lucas

A free translation of Carpenter's description is as follows "Shell similar in shape to *O bullata*, but with entirely different sculpture, nuclear whorls ? (decollated), normal whorls seven, slightly rounded, sutures impressed, with about 14 subacute radiating ribs, rounded, not varicose, the continuation above the sutures flattened, last whorl with a riblike, irregularly arranged spiral row of tubercles on the periphery, entire surface reticulate, with the interstices deeply, irregularly punctate, punctures, minute, close; base angulated by a nodulous rib, aperture rounded, lip continuous, varicose, not sinuated, operculum (?) pauci-spiral Length 7, length of spire 5, diameter 2 5 mm " To this it can be added that the

[7] Proc U S Nat Mus., vol. 53, 1917, p 474

ribs end in rounded knobs in the suture, and that the nucleus consists of four well rounded, glassy whorls of which only the last shows signs of sculpture An adult specimen from Catalina Island has been chosen for illustration

3 **Epitonium (Nodiscala) espiritum** Baker, Hanna & Strong, new species

Plate 2, figure 4

Shell of moderate size, elongate-conic, everywhere marked by heavy growth lines, milk-white, nuclear whorls decollated remaining postnuclear whorls seven and a half, strongly exserted, the first three very convex, the rest strongly angulate in the middle, producing a broad slightly concave, sloping shoulder on the upper half and a flattening of the lower part, all whorls marked by low, rounded, irregular, irregularly spaced, slightly retractive axial ribs, about fifteen appearing on all whorls, these ribs terminating superiorly on the lower whorls, and indistinctly on the upper, in rounded, appressed tubercles in the deeply impressed sutures, thus rendering the sutures strongly crenulate, and by from 10 to 20 narrow, rounded spiral cords crossing the axial ribs, separated by well defined sulci which are rendered markedly punctate by the heavy growth lines, base rather long, marked by the same sculpture as the preceding whorls, aperture broadly oval with some flattening on the peripheral side, rendered entire by a heavy continuous callus and showing the external sculpture within Length, 6 mm , diameter, 2 3 mm

Holotype No 4778, Mus Calif Acad. Sci , and two immature paratypes (Nos. 4779, 4780) collected by Fred Baker at **Isthmus Bay, Espiritu Santo Island, Gulf of California.** A paratype in the Baker collection was taken by Capt. Geo. D Porter in the "Gulf of California"

The species differs radically from any other described from this coast

Subgenus Dentiscala de Boury, 1886

This subgenus contains those species with a spiral rib bounding the basal disk, the more or less obsolete ribs coronate the suture and have deep pits between them on the tabulated shoulder of the whorl

4 Epitonium (Dentiscala) crenatoides (Carpenter)

Plate 2, figure 5

Opalia crenatoides Carpenter Ann Mag Nat Hist, ser 3, vol 14, 1864, p 47

One immature specimen was taken at the West Anchorage, San Jose Island, Gulf of California and one at Cape San Lucas, Lower California

A free translation of Carpenter's description of this species is as follows "Shell white, margin of spire straight, nuclear whorls?, normal whorls six, compact, in close contact; axial ribs 10, nearly obsolete on the spire, strong on the last whorl, broad, not elevated, ascending the spire in close, almost straight lines, suture deeply punctured between the ribs, suture continued as a broad basal keel, spaces between the ribs deep, particularly in the sutures, showing subobsolete, subnodose spiral threads, not umbilicated, base smooth Length 13 5, length of spire 9 5, diameter 5 75 mm"

5 Epitonium (Dentiscala) crenimarginatum (Dall)

Plate 2, figure 6

Dentiscala crenimarginata Dall, Proc U S Nat Mus vol 53, 1917, p 473

Thirty-three specimens were taken at Smith Island, two at Balandra Bay, Carmen Island, three at the West Anchorage, San Jose Island, one at San Marcos Island, three at Georges Island, fourteen at Sal si Puedes Island, three at Isla Partida, all in the Gulf of California, one at Las Animas Bay and three at San Antonio Point, Lower California

In the original description of *Epitonium crenimarginatum* it was stated that the species had been confused with *Epitonium crenatoides* (Carpenter) The latter is a rare and little known

Gulf shell but the name has been commonly applied to the former species which ranges as far north as Monterey, California, as shown by the various published lists *Epitonium crenimarginatum* (Dall) is characterised by having about 12 axial ribs, strong on the spire, obsolete on the last two whorls, the whorls finely spirally striated, the base smooth

Carpenter described under the name of "*Opalia* (?*crenatoides*, var) *insculpta*,[8]" a Pleistocene fossil from Santa Barbara with 13 or 14 ribs, strong on the spire, obsolete on the last whorl, spiral sculpture none Dall stated of this that it is somewhat intermediate between the two above noted but without the fine spiral surface sculpture As the spiral striations on the living shells is on a surface coating which is easily eroded, leaving a smooth underlayer, this character is not of specific value It is not improbable that a study of well preserved material from the Pleistocene will show that *insculptum* (Carpenter) and *crenimarginatum* (Dall) are identical One other species, *Epitonium nesioticum* (Dall),[9] from Catalina Island, California, is placed in the subgenus It is smaller, with 12 ribs and sharp spiral sculpture

Subgenus **Asperiscala** de Boury, 1909

This subgenus contains those species without a basal disk in which the surface between the varicose ribs is marked with spiral sculpture To the single species described by Carpenter, Dall added 13 more from the west coast Three of these were found in the Academy's material and a single specimen of another seems to represent a new species

6 **Epitonium (Asperiscala) kelseyi** Baker, Hanna & Strong, **new species**

Plate 2, figure 7

Shell of medium size, rather obese, with straight sides, shining white, nuclear whorls about two, high and prominent, the first somewhat eroded, the second showing a minute thim-

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[8] Ann Mag Nat. Hist , ser 3 vol 17, 1866, p. 277
[9] Proc U S Nat Mus. vol 53 1917 p 473

ble-pitting in spots; transition to postnuclear sculpture not well defined, postnuclear whorls nearly eight and a half, slopingly shouldered above, strongly and evenly rounded below the shoulder, marked by eighteen thin, slightly reflected, irregular and irregularly placed, varices, which are depressed at the sutures, but raised at the shoulder to rounded tubercles which occasionally become spinose, varices not continuous up the spire which they encircle about ¼, interspaces wider than the varices, everywhere marked by irregular and irregularly spaced, incised spiral lines quite generally showing faintly on the varices, postnuclear whorls marked throughout by minute growth lines reaching the anterior surfaces of the varices, sutures deep and well defined between the varices, base well rounded, without a basal disk, aperture ovate, slightly effuse below, outer lip somewhat fractured but thin, indicating probable immaturity, basal lip and parietal wall with a broad callus reflected above, and free from the ends of the varices in such a manner as scarcely to hide the umbilicus Length, 11 9 mm, diameter, 5 5 mm

Holotype No 4766, Mus Calif Acad Sci, collected by Fred Baker at **San Francisco Island, Gulf of California,** 1921

This species probably resembles *E imperforatum* Dall[10] more closely than any other from this coast, but it is larger, has fewer varices, a thimble-pitted nucleus and, apparently, a greater tendency to become spinose at the shoulder, besides being perforate It appears to us that this last criterion is not of great taxonomic importance in *Epitonium* because the usual broad callus of the columellar region may easily obscure a quite large umbilicus However, the very free reflection of the callus in this species makes obscuration very improbable at any stage of growth We are inclined to agree with Dall[11] rather than with de Boury,[12] that the number of varies, at least in the

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[10] Proc U, S Nat Mus, vol 53 1917 p 476

[11] The number of varices is, on the whole, very constant in most of the groups, following the rule that the greatest variation will be found where the normal number of varices is greatest " Proc U S Nat Mus., vol 53, 1917 p 471

[12] "Bien que le nombre des côtes axiales soit une indication relativement très utile dans nombre de cas, il est souvent si variable, même chez les especes à côtes peu nombreuse, qu'il faut n'en tenir compte qu'avec une extrême prudence et ne pas y attacher la même importance que notre savant collègue, qui attribue a ce caractère une constance en réalité très relative." Jour de Conch., vol 64, 1918, p 34

majority of our west coast species, is generally a dependable criterion

The species is named for Mr F W Kelsey of San Diego, California

7 Epitonium (Asperiscala) acapulcanum Dall

Plate 2 figure 8

Epitonium acapulcanum Dall, Proc U S Nat Mus, vol 53, 1917, p 475

A single specimen was taken at Isthmus Bay, Espiritu Santo Island, Gulf of California

This species is characterized by Dall as having 11 varices, without spinosity at the shoulder, the whorls covered with closely adjacent flattish threads, the three nuclear and five subsequent whorls measuring 5 mm. in length by 2 5 mm in diameter Our specimen has six whorls and is slightly larger than the type in all dimensions It seems to agree in most particulars but the varices are slightly less retractive The number of threads in the intercostal spaces of the penultimate whorl is about twenty

8 Epitonium (Asperiscala) xantusi Dall

Plate 3, figures 1, 2

Epitonium xantusi Dall, Proc U S Nat Mus, vol 53, 1917, p 475

A single specimen taken at Isthmus Bay, Espiritu Santo Island, Gulf of California, and about two dozen specimens at Cape San Lucas, Lower California, seem to fall here

The species is characterized by Dall as having 12 low, continuous varies, not spinose or expanded over the suture, the interspaces on the whorls with flattish adjacent threads, the seven decollated whorls measuring 5 5 mm in length by 3 mm in diameter None of our specimens reach quite the seven whorls of the type and the measurements are proportionally smaller The nuclear whorls are nearly three, axially retrac-

tively, very minutely striated, the direction agreeing with that of the varices The intercostal spiral cords number from eight to twelve, nearly equal, equally spaced and very distinctly marked.

9 Epitonium (Asperiscala) cookeanum Dall

Plate 3, figure 3

Epitonium cookeanum Dall, Proc U S Nat Mus, vol 53, 1917, p 475

A single beachworn specimen from Isthmus Cove, Espiritu Santo Island, Gulf of California, agrees with Dall's description and with a specimen from Ocean Beach, near San Diego, in Dr Baker's collection No type locality was designated in the original description but the range was stated to be from San Diego to Gulf of California Dr Baker's specimen is marked "co-type" and is believed to have been received from Miss Cooke, it is very probably part of the type lot and has been chosen for figuring here

Subgenus Nitidoscala, de Boury, 1909

This subgenus contains those species without a basal disk in which the surface of the whorls between the varices is without spiral sculpture The majority of the species from the west coast belong in this subgenus, the total number being nearly 50 Many of these are only known from type specimens and there has been much confusion in the application of the older names Only four species falling in the subgenus were found in the Academy's Gulf material

10 Epitonium (Nitidoscala) apiculatum Dall

Plate 3, figures 4, 5, 6

Epitonium apiculatum Dall, Proc U S. Nat Mus, vol 53, 1917, p 480

Two specimens were taken at the Salt Works, Carmen Island, two at Amortajada Bay, San Jose Island, one at Isthmus Bay, Espiritu Santo Island, all in the Gulf of California;

three at La Paz, one at San Evaristo Bay and two at Coyote Bay, Conception Bay, Lower California

This species is characterized by Dall as having eight sharp varices, acutely angled at the shoulder and becoming spinose on the last whorl, the 2½ nuclear and five subsequent whorls measuring 4 mm in length by 2 mm. in diameter The species was evidently described from an immature individual We figure an immature specimen which agrees very closely with the type-description and another with seven and a half post-nuclear whorls, this last is 9 2 mm in length and 3 3 mm. in diameter, the varices are continuous and make nearly a whole turn of the spire

11. Epitonium (Nitidoscala) propehexagonum Dall

Plate 3, figure 7

Epitonium propehexagonum Dall, Proc U S Nat Mus, vol 53, 1917, p 479

One specimen from Puerto Escondido, Lower California, one from Sal si Puedes Island and one from San Luis Island, Gulf of California, seem to fall here

Dall separated this species from the wider ranging *Epitonium hexagonum* (Sowerby), the only other species from the west coast with six varices, by the larger size, broader proportions and greater tendency to spinosity on the varices at the shoulder of the whorls Judging from the description alone our specimens possess these characters

12 Epitonium (Nitidoscala) hexagonum (Sowerby)

Plate 3, figure 8

Scala hexagona Sowerby, Proc Zool Soc, London, 1844, p 29
Epitonium hexagonum (Sowerby), Dall, Proc U S Nat Mus, vol 53, 1917, p 479

A single specimen from Isla Danzante, Gulf of California, seems to fall in Sowerby's species as restricted by Dall.

13 Epitonium (Nitidoscala) colpoicum Dall

Plate 3, figure 9

Epitonium colpoicum Dall, Proc U S Nat Mus, vol 53, 1917, p 478

A single specimen from Ballandra Bay, Carmen Island, Gulf of California, has one more whorl than the original description calls for and it is accordingly larger The lack of any indication of coronation to the varices and the "pit-like cavities" in the suture between the varices make this species quite distinct from any other described form.

PLATE 2

Fig. 1 *Epitonium golischi* B. H & S., n sp. Holotype No. 4770 (C. A. S.), San Francisco Island, Gulf of California; length 13.0 mm., diameter 5.8 mm , p. 44.

Fig 2. *Epitonium golischi* B H. & S., n. sp. Paratype No 4771 (C. A S.), Puerto Escondido, Gulf of California, length 7.6 mm.; diameter 3 5 mm , p 44.

Fig. 3 *Epitonium retiporosum* (Carpenter) Plesiotype No 4777 (C. A. S.), White's Landing, Catalina Island, California, 30 fms , length 9 5 mm , diameter 3 3 mm , p 45

Fig 4. *Epitonium espiritum* B. H & S , n sp Holotype No. 4778 (C. A. S.), Isthmus Bay, Espiritu Santo Island, Gulf of California, length 6.0 mm.; diameter 2.1 mm , p 46

Fig 5 *Epitonium crenatoides* (Carpenter) Plesiotype No. 4768 (C A S), west side San Jose Island, Gulf of California; length 9 8 mm , diameter 4.2 mm.; p. 47.

Fig. 6 *Epitonium crenimarginatum* (Dall) Plesiotype No 4774 (C. A S); San Marcos Island, Gulf of California, length 18 8 mm , diameter 7.3 mm , p 47

Fig. 7 *Epitonium kelseyi* B. H. & S , n sp. Holotype No. 4766 (C A S), San Francisco Island, Gulf of California, length 11 9 mm , diameter 5.5 mm , p 48

Fig 8. *Epitonium acapulcanum* Dall. Plesiotype No 4769 (C A S.), Isthmus Bay, Espiritu Santo Island, Gulf of California, length 6 2 mm., diameter 2 9 mm ; p. 50


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PLATE 3

Fig 1 *Epitonium xantusi* Dall Plesiotype No 4775 (C A S), Isthmus Bay, Espiritu Santo Island, Gulf of California, length 4 mm, diameter 1 9 mm, p 50

Fig 2 *Epitonium xantusi* Dall Plesiotype No 4776 (C A S), Cape San Lucas, Lower California, length 5 5 mm, diameter 2 8 mm, p 50

Fig 3 *Epitonium cookeanum* Dall Plesiotype in the collection of Dr Fred Baker, Ocean Beach, San Diego, California, length 7 1 mm, diameter 3 2 mm, p 51 This specimen is probably from the type lot returned by Dr Dall, it is more important than an ordinary plesiotype

Fig 4 *Epitonium apiculatum* Dall Plesiotype No 4763 (C A S), Salt Works, Carmen Island, Gulf of California, length 9 2 mm, diameter 3 3 mm, p 51

Fig 5 *Epitonium apiculatum* Dall Plesiotype No 4764 (C A S), La Paz, Lower California, length 3 8 mm, diameter 1 7 mm, p 51

Fig 6 *Epitonium apiculatum* Dall Plesiotype No 4765 (C A S), Isthmus Bay, Espiritu Santo Island, Gulf of California, length 4 mm, diameter 1 7 mm, p 51

Fig 7 *Epitonium propehexagonum* Dall. Plesiotype No 4772 (C A S), Inner Lagoon, San Luis Island, Gulf of California, length 18 7 mm, diameter 7 7 mm, p 52

Fig 8 *Epitonium hexagonum* (Sowerby) Plesiotype No 4767 (C A S), Isla Danzante, Gulf of California, length 14 1 mm, diameter 5 7 mm, p 52

Fig 9 *Epitonium colpoicum* Dall Plesiotype No 4773 (C A S), Ballandra Bay, Carmen Island, Gulf of California, length 13 2 mm, diameter 6 9 mm, p 53

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PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XIX, No. 6, pp 57-64 JULY 15, 1930

VI

PLIOCENE DEPOSITS NORTH OF SIMI VALLEY, CALIFORNIA

BY

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The youngest Tertiary rocks on the south slope of the Santa Susana Mountains north of Simi Valley, in eastern Ventura and western Los Angeles counties, consist of sandstones and conglomerates that lie unconformably on beds ranging in age from upper Miocene to Eocene Though they are the youngest consolidated deposits in this region, they embrace rocks that are far harder than any of the other Tertiary rocks, they cap high ridges and supply the most durable rock waste to the streams

These beds, which are several hundred feet thick in the eastern part of the area described and thicken westward, were described by Kew,[1] who referred them to the Fernando formation and on the basis of a collection of fossils from "Browns Canyon below the abandoned wells" recognized their Pliocene

[1] Kew, W S. W, Structure and oil resources of the Simi Valley, southern California: U S. Geol Survey Bull 691, pp. 333-334, 1919

age and that they are younger than the Pliocene beds of Elsmere Canyon near Newhall Later Kew[8] referred these deposits to the Saugus formation and listed a few fossils from additional localities in this region

These Pliocene beds were examined during the course of work carried on by the 1929 summer field camp of the California Institute of Technology by parties headed by F D Bode, J W Daly, W A Findlay, K E Lohman, and G. F Taylor Any credit for the additional information discovered belongs to these students and their collaborators, who performed the arduous work of mapping and fossil-collecting Not enough time was spent on this part of the Tertiary section to yield precise stratigraphic results in the way of measurements and possible subdivisions These matters are now being investigated by G H Anderson, of the California Institute of Technology The fossils collected during the work of the summer field camp confirm Kew's original age assignment and show that at least the lower part of these beds falls within a division of the Pliocene series that furnishes a readily recognized datum horizon in southern California The fossils and the localities where they were collected are as follows·

[8]Kew, W S W, Geology and oil resources of a part of Los Angeles and Ventura counties California U S. Geol Survey Bull. 753, pp. 69-70, 81-89, 1924.

Pliocene fossils from localities north of Simi Valley

	433	435	434	457	436	440	445	437	441	446	439	442	451	447	438	450	448
Lamellibranchs																	
Ostrea vespertina Conrad	×	×	×	×	×		×	×		×		×	×			×	
Pecten bellus hemphilli Dall	×			×				×					×		×	×	×
Pecten stearnsii Dall		×															
"Pecten" healeyi Arnold						×	×					×					
"Pecten" cerrosensis Gabb[3]																	
"Pecten" veatchii Gabb					×												
"Pecten" purpuratus Lamarck var							×						×				
"Pecten" invalidus Hanna?[3]														×			
"Pecten" latiauritus Conrad?			×														
Chlamys hastatus (Sowerby)					×		×					×					
Chlamys opuntia (Dall)		×		×					×			×				×	
Chlamys swiftii parmeleei (Dall)				×									×				
Monia macroschisma (Deshayes)																	
*Modiolus rectus (Conrad)?								×									
*Lithophaga					×												
*Cardita ventricosa Gould?																	
*Miltha cf xantusi (Dall)	×	×															
*"Cardium"?															×		
Echinoids																	
Strongylocentrotus cf franciscanus (A Agassiz)				×													
Dentraster diegoensis Kew?								×					×				
Dentraster cedrosensis Israelsky													×				

*Specimens represented by molds.

[3] I am indebted to Dr H. R. Gale for pointing out the names to be used for these species.

Pliocene fossils from localities north of Simi Valley—Continued

	433	435	434	457	436	440	445	437	441	446	439	442	451	447	438	450	448
Bryozoa																	
Cauloramphus										X							
Smittina								X									
Brachiopod																	
Dallinella occidentalis (Dall)		>							X	X		X					
Gastropods																	
*Astraea?																	X
*Calliostoma															X		
*Odostomia?															X		
*Epitonium fallaciosum Dall?							X										
Opalia varicostata Stearns							X										
*Neverita cf recluziana (Deshayes)																	X
*Bittium								X							X		
Forreria wrighti Jordan and Hertlein?							X										
*Mitrella																	X
*Nassarius																	X
*Neptunea?															X		
*Conus californicus Hinds?															X		X
*Acteon																	X

*Specimens represented by molds

California Institute of Technology locality numbers

433 East of Aliso Canyon, cliff at end of road near center of sec 36, T 3 N, R 17 W, 7400 feet N 58° E from Rocky Peak G F Taylor

435 East of Aliso Canyon, south line of sec 25, T 3 N, R 17 W, on northward-facing cliff in burned-over area, 7650 feet N 45½° E from Rocky Peak J W Daly

434 Spur east of Aliso Canyon, western part of sec 36, T 3 N, R 17 W, 30 feet above fault contact with Eocene, 6800 feet N 64½° E from Rocky Peak J W Daly

457 West of Aliso Canyon, east slope of ridge near center of sec 26, T 3 N R 17 W, 8800 feet N 12½° E from Rocky Peak G F Taylor

436 West side of Las Llajas Canyon, about 100 feet below top of cliff section 2750 feet N 68° E from 2205-Hill W A Findlay and J Reilly

440 Same locality as 436, but about 75 feet below top of cliff section W A Findlay and J Reilly

445 Same locality as 436, immediately below lowermost conglomerate in cliff section W A Findlay and W P Woodring

437 On ridge between forks of first canyon west of Las Llajas Canyon, 5950 feet N 27½° E from 2205-Hill W A Findlay and J Reilly

441 East of Dry Canyon, 5500 feet N 36° W from 2205-Hill W A Findlay

446 East of Dry Canyon, 4550 feet N 36½° W from 2205-Hill J Reilly

439 East of Dry Canyon, 5200 feet N 39° W from 2205-Hill J Reilly

442 East side of Dry Canyon near top of ridge, 7000 feet N 45° W from 2205-Hill W A Findlay and J Reilly

451 East of Dry Canyon, south slope of 2075-Hill, peak of which is 1650 feet N 79° W K E Lohman and W B Maitland

447 East of Dry Canyon, south slope of 2075-Hill, peak of which is 950 feet S 54° E K E Lohman and W B Maitland

438 West side of main branch of Dry Canyon, 2000 feet N 58½° W from 2075 Hill K E Lohman and W B Maitland

450 West side of main branch of Dry Canyon, 2100 feet N 54½° W from 2075 Hill K E Lohman and W B Maitland

448 Main branch of Tapo Canyon, road cut about 30 feet north of pumping plant, 450 feet S 40½° W from 1794-Hill K E Lohman and W B Maitland

It is apparent from the preceding list that these fossils represent a warm-water Pliocene fauna, which has been found at localities from Lower California northward to the Ventura Basin and which is best known as the fauna of the San Diego formation *"Pecten" veatchii* Gabb, a tropical *Nodipecten* described from Cedros ("Cerros") Island, Lower California, heretofore has not been recorded so far north Many other

species in this list are found in the Pliocene deposits of Cedros Island[4] and at San Diego So far as I know the only locality around the borders of the Los Angeles Basin where this fauna is found is near the mouth of Temescal Canyon northwest of Santa Monica where the following fossils were collected.

Pliocene fossils from Temescal Canyon

55 West side of Temescal Canyon, 200 yards above mouth, massive gray sandstone H W Hoots and W P Woodring

Brachiopod
- Dallinella occidentalis (Dall)

Gastropod
- Opalia varicostata Stearns

Lamellibranchs
- Ostrea vespertina Conrad
- Pecten bellus hemphilli Dall?
- Pecten stearnsii Dall
- "Pecten" healeyi Arnold
- "Pecten" cerrosensis Gabb
- "Pecten" purpuratus Lamarck var
- Chlamys hastatus (Sowerby)
- Chlamys opuntia (Dall)
- Chlamys swiftii parmeleei (Dall)
- *Phacoides annulatus (Reeve)?
- *Miltha cf xantusi (Dall)

*Specimens represented by molds

The San Diego affinities of the fossils from this locality were recognized by Arnold[5] The similarity of this small fauna to that found at many localities north of Simi Valley is striking, and it is quite clear that the same faunal zone is represented There are not many Pliocene faunal zones in southern California that can be so definitely recognized at such widely separated localities and the beds constituting this zone should have a uniform stratigraphic nomenclature The deposits north of Simi Valley certainly should not be called the Saugus formation, at least not until it is conclusively shown that the type nonmarine Saugus formation grades laterally into this zone. The name Saugus formation has been used as a catch-all for almost any Pliocene and Pleistocene beds in the

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[4]See Jordan, E. K., and Hertlein, L. G., Proc Calif Acad. Sci, 4th ser, vol 15, no 14, 1926, pp 409-464.

[5]Arnold, Ralph, *New and characteristic species of fossil mollusks from the oil-bearing Tertiary formations of Southern California* Proc. U S. Nat. Mus., vol. 32, p 527, 1907

Ventura and Los Angeles basins In the Las Posas Hills, not more than 15 miles southwest of Simi Valley, the so-called Saugus formation consists of a lower part carrying a cool-water upper Pliocene fauna and an upper part carrying a warm-water, presumably interglacial, Pleistocene fauna, according to Pressler's account [6] For the Pleistocene beds Pressler proposed the name Las Posas formation As Pressler surmised, the beds referred to the Saugus formation north of Simi Valley are older than any part of the Las Posas Hills section The cross-bedded sands and gravels that are well exposed on the Grimes Canyon road, northwest of Simi Valley, probably represent the landward edge of the Las Posas formation [7] These beds constitute the upper division of the Saugus formation of this region as described by Kew [8] By tracing westward from the region north of Simi Valley the beds carrying the fauna of the San Diego formation it should be possible to determine the relations of the Pliocene and Pleistocene parts of the so-called Saugus formation

Beds carrying a San Diego fauna could be given a new name in each basin, which would complicate an already cumbersome nomenclature, they could be called the San Diego formation regardless of where they are found, just as deposits of Paleocene age in California are referred to the Martinez formation wherever they are found, or a zonal nomenclature could be adopted and they could be referred to as the *healeyi*-zone (after *"Pecten" healeyi*), or by some other fossil name that would instantly bring to mind the San Diego fauna The latter course seems to be the preferable one, for it would yield a definite meaning Whether the San Diego formation and equivalent deposits elsewhere are called middle Pliocene or upper Pliocene depends on where the Pliocene-Pleistocene boundary is placed H R Gale and U S Grant IV, of Stanford University, who are completing a study of the Pliocene and Pleistocene of southern California, consider these deposits middle Pliocene

The fossils collected north of Simi Valley and in Temescal Canyon represent only a small fraction of the fauna living

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[6] Pressler, E D, The Fernando group in the Las Posas-South Mountain District, Ventura County, California Univ Calif Bull Dept Geol Sci. vol 18 No 13, pp. 325-345, 4 figs., 1929

[7] Idem, p 344

[8] U S. Geol Survey Bull 753, p 85 1924.

when these beds were laid down and the question arises as to the significance of the presence of a few things and the absence of many The solution seems to be relatively simple and to involve nothing more subtle than the composition of the fossil remains Virtually the only shells and tests that are preserved intact are those that are composed of calcite, that is, brachiopods, echinoids, oysters and Pectens among the lamellibranchs, and Epitonids among the gastropods One of the Epitonids (locality 445) is badly leached, but the Opalias are perfectly preserved The host of mollusks with less durable aragonite shells are not represented at all or are sparsely represented at a few places by impressions and molds, to which some of the shell may still be attached, with the exception of the *Forreria*, which consists of a shell fragment, and the *Monia*, which is perfectly preserved aside from the loss of the inner nacreous layer The collections consist principally of a monotonous repetition of oysters, which are the most abundant fossils, and Pectens, of which there is a surprising number of species, with an addition of brachiopods and echinoids here and there In Temescal Canyon brachiopods are extraordinarily abundant and present an amazing range of variation, but at this locality echinoids are represented by only a few small spines The fossil-bearing bed in Temescal Canyon consists of coarse sandstone and north of Simi Valley the beds are coarse sandstones and conglomerates The water that readily percolated through these porous beds quickly dissolved the aragonite shells Furthermore, the absence of even molds of aragonite-shelled mollusks at most localities indicates that the shells generally were dissolved before the sediments were cemented Unless some fine-grained sediments are found, there seems to be little hope of obtaining a representative collection from these deposits

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XIX, No. 7, pp 65-83, 3 text figs JULY 15, 1930

VII

GEOLOGY OF SHARKTOOTH HILL, KERN COUNTY, CALIFORNIA

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INTRODUCTION

In order to explain the geology of Sharktooth Hill and the strata from which were obtained the fossils which are to be described in the Academy's Proceedings, it has been necessary to give consideration to some of the surrounding area The information has been accumulating through a period of years but even yet, it is believed, insufficient work has been done to warrant more than a general statement regarding some of the points discussed Undoubtedly this will be looked upon as a deficiency by those who have pursued much more detailed studies in certain cases, but it is felt that the course followed has obviated any very serious errors

So many people have contributed to make this report possible that it is impracticable to mention all However the friendly spirit of cooperation which has been invariably shown is most deeply appreciated

Location

Sharktooth Hill is located on the north side of Kern River in Sec 25, T 28 S , R. 28 E., M. D. M., Kern County, California This is about seven miles northeast of Bakersfield The hill is a somewhat isolated prominence set back from the river about one-fourth mile The elevation is given as 643 feet on the Caliente sheet of the U S Geological Survey's topographic map, but the hill is not named thereon The road to the Round Mountain oil field passes to the south

The section on which Sharktooth Hill is located belongs to the Southern Pacific Land Company

History

The locality has long been known for the great numbers of teeth of sharks which might be picked up from the surface of the slopes of the hill. Large collections of these are in numerous museums Several species of sharks are represented and the size of the teeth varies from a length of 10 millimeters in *Gyrace* to over 100 millimeters in the giant *Carcharodon*

Much study has been devoted to these teeth in the past by Louis Agassiz, David Starr Jordan and his associates, a list of important publications is given below [1]

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[1] Agassiz, L. Notice of fossil fishes found in California by W P Blake. Amer Jour Sci. & Arts, ser 2, vol 21, 1856, pp 272-275 Notice of the fossil fishes Explorations and surveys for a railroad from the Mississippi River to the Pacific Ocean, vol 5, 1857; Geological Report by William P Blake, Appendix, Article 1, pp. 313-316, pl 1

Jordan, D S The fossil fishes of California with supplementary notes on other species of extinct fishes Univ Calif Publ Bull Dept Geol vol 5, no. 7, 1907, pp 95 144, pls. 11, 12, 33 text figs.

Leriche, Maurice Observations sur les Squales Néogènes de la Californie Annal Soc. Geol. du Nord, vol 36, 1908, pp 302-306

Jordan, D S & C. H Beal Supplementary notes on fossil sharks Univ Calif Publ Bull Dept Geol vol 7, no. 11, 1913, pp 243-256, 8 text figs

Jordan, D S & J Z Gilbert Fossil fishes of the (Miocene) Monterey formations of Southern California. Leland Stanford Jr Univ Publ Univ Ser , in "Fossil fishes of southern California," art. 2, 1919, pp 13 60, pls 1 31

Jordan, D S Some sharks' teeth from the California Pliocene Amer Jour Sci ser 5, vol 3, 1922, pp. 338-342, 9 text figs.

Jordan, D S & H Hannibal Fossil sharks and rays of the Pacific Slope of North America. Bull Southern Calif Acad. Sci. vol. 22, pt. 2, 1923, pp 27-63, pls. 1 14

Leriche, M Les Poissons Néogènes de la Belgique Mem Mus. Roy d'Hist Nat Belgique, no 32, 1926, pp 365 472, pl 28 41

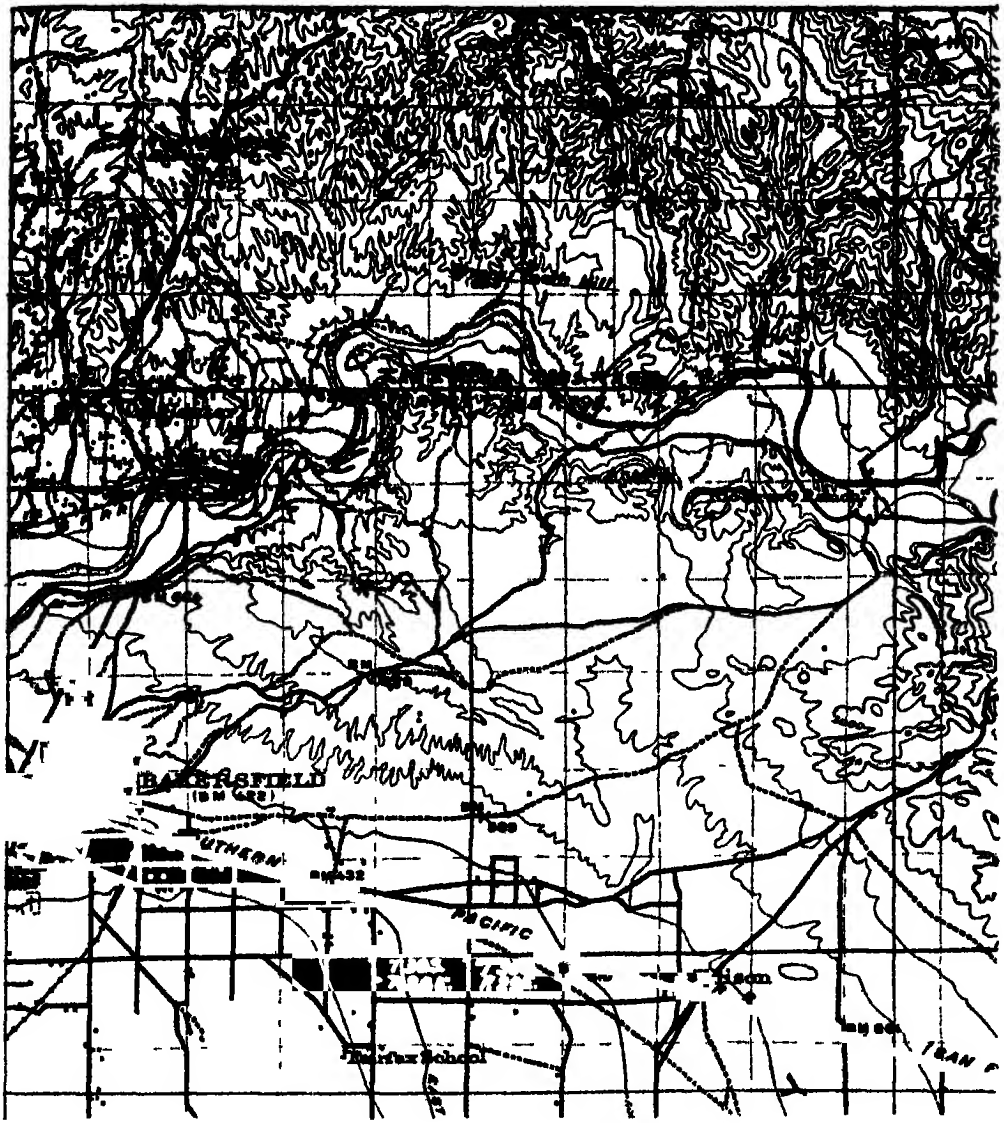

Fig 1 Part of U S Geological Survey, Topographic Map, Caliente Sheet, Kern County, California, showing Sharktooth Hill and other prominent points.

No record has been kept of the many visitors who have gone to the hill for the purpose of collecting teeth, but the number is very large. One of the first to make a fairly representative scientific collection, however, was Mr. Frank M. Anderson, long associated with the Department of Paleontology of the California Academy of Sciences. His material was studied by Jordan & Beal in their report on fossil fishes of California.

Before that, that is in November 1909, Mr Charles Morrice was attracted to the locality because of its fossils He was employed by the Pacific Oil Company and stationed at Oil Center near the eastern margin of the Kern River Oil Field. This was sufficiently near to Sharktooth Hill so that he could spend his leisure hours there collecting He soon located the stratum which had produced the teeth found weathered out on the surface and a vast number, beautifully preserved, came into his collection Always generous and considerate of others' wishes, Mr Morrice distributed his finds widely and they formed the very foundation of some studies of fossil sharks subsequently undertaken.

Fortunately, through the kindness of Mr Morrice, I am able to give his own account of his many years as a collector of marine vertebrates at this locality Under date of December 10, 1929, he wrote as follows.

"I first became interested in collecting fossils about November, 1909 Some of my acquaintances, observing that I took long excursions on Sundays asked me if I had ever visited Sharktooth Hill I had not and it took me several weeks to locate it. Once found, my hobby became collecting sharks' teeth

"All of the teeth which had been gathered at the place up to this time, as well as those in the collection which had been made by Mr Barker on his ranch on the south side of the river had been more or less leached by exposure to the weather This is evident from the illustrations in the paper on fossil fishes of California by Dr David Starr Jordan, published in 1907.[3]

"I carried, first a pick and then a shovel to the hill, which was about five miles east of my residence, and made an excavation about four or five feet deep. This resulted in securing many beautifully preserved

[3] Jordan, D S Univ Calif Publ Bull. Dept Geol vol. 5, no 7, 1907 pp 95 144, pls 11 12

specimens in a fine, hard silt or mud which effectively protected the enamel of the teeth

"In about six months I had gathered several hundred specimens and having become acquainted with Mr F M. Anderson I showed them to him. He suggested that I write to Dr. Jordan for a copy of his paper referred to above, in order that I might be able to classify the collection. This I did but my letter was lost, much to my chagrin. Some months later I told Mr. Anderson of my failure to receive the copy of the paper and he promised to send me his own, which he did. When Dr. Jordan finally learned of my efforts and desire for literature on the subject he very courteously sent me an autographed copy.

"By early 1912 my collection amounted to about 2,000 specimens, including bones and teeth of the sea lion, later named *Allodesmus kernensis* by Dr Kellogg. Upon consulting Mr Anderson as to the disposition of the material, he suggested three institutions worthy of receiving it, namely: Stanford University, University of California and California Academy of Sciences

"After due consideration I sent the entire collection to Mr Anderson for the California Academy of Sciences for such disposition as might seem best. It was suggested that only duplicates be given to other institutions

"In about six months more I had gathered together about 1,500 additional specimens These I sent to Dr Jordan for Stanford University and they, with the collection already presented to the Academy, formed the basis of the good Doctors' 'Supplementary notes on fossil sharks' published in 1913.[a]

"My next collection of over 1,000 specimens was sent to Dr. J C. Merriam for the University of California. Other collections made later were sent to University of Neveda; University of Wisconsin, Southern California Academy of Sciences, Universities of Lille, France; Brussels, Belgium, Aberdeen, Scotland; and to the High School and Chamber of Commerce of Bakersfield, California.

"During the summer of 1922 Dr Remington Kellogg and Dr Bruce L. Clark of the University of California, accompanied by several other gentlemen, visited me and we made an excursion to the Sharktooth Hill deposit. In a short time we uncovered enough bones to arouse their interest. At Dr Kellogg's request I began sending fossil bones to him at the U. S National Museum and this continued until 1924 when the skull of *Aulophyseter morricei* was shipped.

"In the fall of 1924 through the interest of the California Academy of Sciences, Mr. Tom Harbert was employed during October, November, and December and the large collection being described by Dr Kellogg was then obtained.

"Dr. Jordan visited me in 1923 and again in 1924; large collections were given him on each occasion Some of these specimens were used

[a] Jordan, D. S & C. H. Beal. Univ Calif. Publ Dept. Geol vol. 7, no. 11, 1913, pp. 243 256, 8 text figs

in the paper published by the Southern California Academy of Sciences in 1923 by him and Harold Hannibal[4]

"Along with the teeth of sharks there were many ear bones of dolphins and bones of seals and sea lions which Dr. Jordan transmitted to Dr Kellogg.

"After every shipment of bones to Dr Kellogg he wrote very interesting accounts of the 'finds' These consisted of bones of dophins, porpoises, seals, sea lions, whales and sea cows. His letters were so inspiring that it was indeed a pleasure to have worked with him. My greatest regret is that I did not make his acquaintance at an earlier date so that many specimens of bones, cast aside in the search for sharks' teeth, might have been preserved"

Previous to Dr. Kellogg's visit in 1922, Mr Morrice had already saved a considerable number of bones and teeth of what appeared to him to have belonged to one species of animal. These, together with material obtained by the two collectors together formed the basis for Kellogg's description of the sea lion, *Allodesmus kernensis*[5]

It became evident from the work done up to 1924 that the stratum exposed on Sharktooth Hill contained an enormous number of bones and teeth of marine vertebrate animals Remains of whales and sharks were particularly abundant and the sperm whale *Aulophyseter morricei* was described from the collection sent to the National Museum[5a]

Up to that time no reasonable hypothesis had been evolved to account for the anomalous disassociation of all skeletal elements of the animals and the fragmentary nature of many of the bones The California Academy of Sciences entered into correspondence with Dr Kellogg and Dr. John C. Merriam of the Carnegie Institution of Washington on the subject and conferences were had with Mr. Morrice, Mr. M E Lombardi, then Vice President of the Pacific Oil Company and with Messrs. J E. Taff and E. G. Gaylord, Geologists for the company After due consideration of all interests and factors it

[4] Jordan, D S. & H. Hannibal. Bull Southern Calif Acad. Sci. vol. 22, pt. 2, 1923, pp. 27-63, pls. 1-14.

[5] Kellogg, R. Univ Calif Publ. Geol. Sci vol 13, no. 4, 1922, pp. 26-114, 19 text figs.

[5a] Kellogg, R. Study of the skull of a fossil sperm-whale from the Temblor Miocene of southern California. Carnegie Inst. Washington, Publ. no. 346, 1927, pp. 1-24, pls 1 9

was decided early in 1924 that the Academy should undertake some more extensive excavations than had theretofore been attempted.

The field work was under the immediate supervision of Mr Morrice whose services were gratuitous Mr Tom Harbert was employed as assistant continuously for the last three months of 1924, and it was during this period that the greater part of the collection to be reported upon by Dr Kellogg was obtained This report amply illustrates the wealth of material in the Sharktooth Hill deposit The author has commented at times on the unfortunate disassociation of the skeletons and the fragmental nature of many of the bones The preservation is normally very good, but how to account for broken pieces of limb bones and ribs in close proximity to vertebra and other delicate bones is a problem for which no satisfactory solution has yet been suggested

Geologic Section

The total thickness of sediment exposed on Sharktooth Hill is about 200 feet The strata dip to the southwest at low angles, the maximum being about 6°. The top of the hill is composed of unconsolidated sands and gravels belonging to the Kern River Series with an important unconformity at the base This unconformity is not characterized by any very noticeable discordance in dip or strike of the strata, but it is known that it marks the absence of several thousand feet of sediment On Sharktooth Hill the contact is not well exposed but the upper layer of the Temblor outcrops as a consolidated sandstone containing many fossil mollusca This outcrop is within 50 feet of the top of the hill on the southeast side

Between the shell layer and the bone bed there is a zone of 30 feet of loosely consolidated sands and sandy shales not well exposed The bone bearing layer itself is about four feet thick with the bones and teeth most abundant near the bottom. The matrix is loosely consolidated and poorly sorted sand with occasional small pebbles The bone and shell beds

together constitute the type locality of zone "C" of F M Anderson.[8]

Below the bone bearing stratum there is a zone of brown sandy shales about 30 feet thick which have contained abundant foraminifera, but on this outcrop the tests have been dissolved away leaving poor impressions The presence of the large, characteristic *Valvulineria* of this part of the Miocene is easily determined, however, with a hand lens

The diatomite from which the flora to be described in a succeeding paper was obtained, outcrops immediately below these sandy shales and extends downward to the base of the hill All of the diatom bearing material is somewhat impure, acidic ash being the chief mineral constituent Some of the layers are light and "punky" and all of them weather to a pale brown color The total thickness exposed is 75 to 100 feet The identification of this horizon over wide areas has been dealt with in the paper describing the flora

The total exposure of strata on Sharktooth Hill is not sufficient to permit a general statement pertaining to the entire Miocene section of this area, but it so happens that several wells have been drilled nearby These have been cored almost continuously and furnish extremely reliable sectional data This will be presented in some detail, but before doing so it will be desirable to comment on the geographic extent of the outcropping and related beds

The shell layer mentioned as occurring at the top of the section is of exceedingly limited distribution. It has not certainly been identified elsewhere by me except on a hill south of Kern River and just west of the lower portion of Cottonwood Creek The presence of *Turritella ocoyana* Conrad is sufficient evidence to indicate the Temblor age of the material

In contrast to this the bone bearing stratum is of very wide distribution on the east side of the valley and has been identified in many outcrops The southernmost exposure lies far to the south of Sharktooth Hill on the divide between the Caliente Creek and Kern River drainage. Sharks' teeth collected there by F M Anderson and Harold Hannibal were

[8] Anderson, F M. The Neocene deposits of Kern River, California, and the Temblor Basin Proc Calif Acad Sci ser 4, vol 3, 1911, p. 85

described by Jordan & Hannibal, the locality being usually indicated as "Bena," a station on the Southern Pacific Railroad nearby.[7]

Traces of bones and teeth may also be found on the old Barker Ranch on the south side of Kern River in Secs 5, 6, T 29 S., R 28 E The diatom horizon outcrops at the river and the structure is so complicated by faulting that the thickness between it and the bone layer could not be determined although it seemed to be greater than on Sharktooth Hill

In a northwesterly direction from the hill the bone layer can be traced by outcrops far to the north, to the old "Fullers Earth Mine" on Granite Creek three miles north of Poso Creek. The matrix at this point is more ashy and less sandy than at Sharktooth Hill and the bones and teeth are found through a vertical thickness of at least 30 feet However, they are much more abundant in the lower portion of the exposure

Another outcrop has been brought to the surface by faulting in a branch of Granite Creek coming from the northwest This is in the northeast corner of Sec. 28, T 27 S, R 28 E, M. D M., and probably is the locality from which Blake made a collection of sharks' teeth during the progress of the Pacific Railroad Survey[8]

The sandy shales mentioned as lying between the bones and diatomite in the Sharktooth Hill exposure form a part of what has come to be recognized by all working geologists of the region as the "*Valvulineria* zone" Outcrops are numerous and usually unmistakable although the fossil from which the zone takes its name has a vertical range of probably 500 feet In fact it extends upward into the base of the Montery at the type locality near the town of that name The association of foraminifera found at the two localities has been the means of determining that the top of the Temblor in this Kern River section is very nearly the stratigraphic equivalent of the base of the type Monterey The difference, if any, cannot amount to more than a few hundred feet of strata It is extremely probable that the diastrophism which caused the termination

[7] Jordan, D S. & H Hannibal Bull So Calif Acad. Sci vol. 22, pt. 2, 1923, pp. 27 63

[8] This collection was described by Louis Agassiz in 1856 and 1857; see footnote no. 1

of marine sedimentation on the east side of the San Joaquin Valley initiated the same in the Monterey area. In many localities where sedimentation was continuous through the period it becomes impossible to draw a sharp line of contact between the Temblor and Monterey This unfortunate circumstance has resulted in the identification of a group of strata as the older formation by some paleontologists while others have referred the same beds to the younger The situation is complicated in other ways and requires very careful analysis

In the immediate vicinity of Sharktooth Hill, exposures are lacking which furnish information on the strata directly below the zone of diatomite at the base of the hill East of the hill, which normally would be down deeper in the section there is a major fault, striking in a general north-south direction The west side of this fault is upthrown several hundred feet; to the east, therefore, for a considerable distance, the formations are marked by Kern River Series and terrace deposits

At the point shown on the map near the letter "K" of "Kern" in the northeast corner of Sec 5, T 29 S, R 28 E, there is a prominent exposure of gray, loosely consolidated sandstone charged with beautifully preserved molluscan fossils The locality has furnished many striking new species, described chiefly by Anderson & Martin [9] The bed became "zone B" of the first author.[10]

The fauna of this zone has become very well known because of the excellent preservation of the fossils and it is often referred to as the *Agasoma barkerianum* zone of the Temblor Conrad[11] described the first fossils from it in 1855 chiefly from sketches of casts and molds made by W P Blake at an unknown locality probably on Poso Creek a few miles to the north Cooper[12] in 1894 added to the list of species, from

[9] Anderson, F M & B Martin. Proc Calif Acad Sci ser 4, vol 4, 1914, pp 15 112, pls. 1-10

[10] Anderson, F M Proc. Calif Acad Sci ser 4 vol 3, 1911, p 85

[11] Conrad, T A. Pacific R. R. Repts House Doc. 129, 33rd Cong. 1855, pp 18-20, Quarto Rept vol 5, 1857, pp. 328 329, pls. 7 9

[12] Cooper, J G Catalogue of California Fossils. Calif State Mining Bureau, Bull 4, 1894, pp 53-54

material collected across the river to the south of the zone B locality, on the old Barker Ranch.

The zone B locality is far enough to the east of Sharktooth Hill so that if the horizontal distance be projected with the dip of the beds there is an apparent vertical distance of approximately 500 feet between it and zone C, this figure was computed by F M. Anderson in defining the zones, but the intervening faulting was not noted Actually the two zones are not widely separated vertically They are really sandy phases of the upper part of the Temblor of this area, and in no cases are they of wide areal extent in the region (Reference is made only to that part of "zone C" at the top which contains the fossil mollusca) The zones are too indefinite and inconstant in lateral distribution to answer the needs of present day stratigraphy and have been practically replaced for map making purposes by the much more persistent zones of micro-fossils Identifiable molluscan fossils are rarely found in the collections made in drilling wells and it is these which have furnished the most complete and reliable information on the geology of region

Below these molluscan bearing sands of the upper Temblor there is a succession of sandy shales carrying an abundance of foraminifera They might all be classed in the general term "*Valvulineria* zone" but differences in the succession of strata show changes in the assemblage of species and the abundance or rarity of particular species, for this reason more or less subdivision is practicable but the details vary among the different workers This subdivision will not here be discussed because it should accompany a detailed discussion of the foraminifera which is yet to be made

This zone of foraminifera-bearing shales is followed by several hundred feet of light gray ashy shales, practically barren of fossils except fish scales and bones The thickness probably varies between 1000 and 1500 feet in most cases Occasional shells are scattered through and foraminifera are found sparingly at several places, thus affording a means for zonal subdivision in some of the most detailed work which has been undertaken. Lithologically there are changes embodying clay, silt, fine sandy shale, fine sand, ashy shale and

occasionally hard calcareous lenses These variations are inconstant in distribution, and it is not believed that any of them, taken alone are now used for correlation purposes.

Toward the base of the ashy shale series, however, this material takes on a peculiar form which can often be recognized The background is pale pearl-gray ashy shale and disseminated throughout there are irregular thin black or dark gray lines, extending in every direction, abundantly but not crowded. The appearance has suggested the name "hair shale zone" The layers of material having this character are limited in thickness and seem to be absent in some cases However, the zone is accompanied by a very striking assemblage of foraminifera found widely distributed in this region and in many other places in California, Oregon and Washington The zone is approximately 250 to 275 feet thick It outcrops on Adobe Creek (a north branch of Poso Creek) where a major fault has lifted the strata on the east several hundred feet

Immediately below this hair shale zone about 250 to 300 feet of ashy and sandy shales carry a fauna of foraminfera in which *Siphogenerma* is dominant This, likewise, is widely distributed in the west although I do not know that it outcrops in the Kern River Region

From this point on down to the base of the Temblor the sediments are predominantly sandy with some strata of gravel and conglomerate The thickness is extremely variable, as might be expected, but an average of 600 feet suggested for the area may not be far wrong

Fossils are notably scarce in the cores taken from wells, enough mollusca have been found, however, to identify the zone definitely with the sandstone strata which outcrop on Pyramid Hill along the granite contact at the east side of the valley The hill is in Sec. 14, T. 28 S, R 29 E and about five miles east northeast of Sharktooth Hill A large and striking assemblage of fossil mollusca has been obtained on Pyramid Hill and, being near the base of the Temblor section, the locality was designated "zone A" by F M Anderson.[18]

[18] Anderson, F M Proc Calif. Acad. Sci. ser 4, vol 3, 1911, p. 85.

The same zone is found at Comanche Point at the south end of the valley and has been tentatively identified at some places on the west side

The Temblor rests on an uneven surface of a series of green, red and blue, often mottled, clays, sandy shales, sands and gravels These have much the appearance of being of continental origin They are pratically non-fossil bearing and have come to bear the name "Walker formation" because there is a limited exposure in Walker Basin Creek in the southeast corner of the valley At that point the shales contain sparingly, fossil land shells but these have not yet helped in determining the age of the formation. Some have thought them to be the equivalent of the Sespe formation, but they may be a phase of the Vaqueros Miocene There are limited outcrops of the material on Pyramid Hill and to the north as far as the point where Granite Creek issues upon the valley plain Excellent exposures are found at Comanche Point beneath the Temblor At none of these places can an adequate conception of thickness be obtained and data derived from the few wells which have penetrated the formation are equally misleading For the sake of record, however, it should be stated that in Sec. 4, T. 26 S., R 27 E., M D. M., the thickness of the Walker was 172 feet

In most of the wells which have gone through the Walker clays and sands, granite has been encountered But in one limited area which includes Secs. 16 and 22, T 26 S., R. 28 E., M D M., the basement rock was slate or shistose rock which possessed all the physical characters of the Mariposa, found outcropping far to the north

The areal geology of the Kern River Region is now known to be characterized by an extremely complicated system of faults These have probably resulted from major and minor fractures in the underlying granite An idea of their extent and general character can probably best be obtained from a study of the granite itself as exposed a few miles to the eastward where joint planes and faults of some significance are extremely numerous and highly irregular in trend And the locations where some of the more obvious breaks occur in the

valley sediments are very well described and shown on a map in a late report by Mr. Leo S Fox[14]

The following sections of two representative and thoroughly sampled wells drilled in the vicinity of Sharktooth Hill are offered to support the statements already made I am deeply indebted to my associate, Mr C. C. Church, for the preparation of these sections and much other assistance through a period of years

Two formation names have been omitted from these sections which some geologists would indicate These are Chanac and Santa Margarita The first has been applied to a certain zone of material which is lithologically very much like parts of the Kern River series but it lies below some marine shales and sands which appear to be Etchegoin Pliocene The name was originally given to a certain landlaid deposit at the south end of the valley from which imperfectly preserved vertebrate fossils have been collected. The evidence to support the theory that the sediments found in the wells about Bakersfield are equivalent in age to the type locality is very meager and is too insecure at this time, it seems to me, to justify the transplantation of the name so far

The basis for recognizing Santa Margarita (upper Miocene) in the wells of the Kern River District is likewise extremely unsafe Below the clays and sands called Chanac there is found a marine zone of sediments containing some foraminifera which are different from typical upper Temblor and upper Etchegoin and it is to this zone that the name has been applied Some competent geologists believe that the evidence indicates an interfingering or overlapping of marine and landlaid material early in the Pliocene because the distinctions have been proved to disappear farther out in the valley from the eastern shore line The fossils found in the so-called Santa Margarita of the wells are not sufficient for this determination because no foraminifera have been found at the type locality of that formation, at least none have been reported

[14] Fox, Leo S. Structural features of the east side of the San Joaquin Valley, California. Bull Amer Assoc Petrol Geol vol 13, no 2, 1929, pp. 101-108, map fig 1

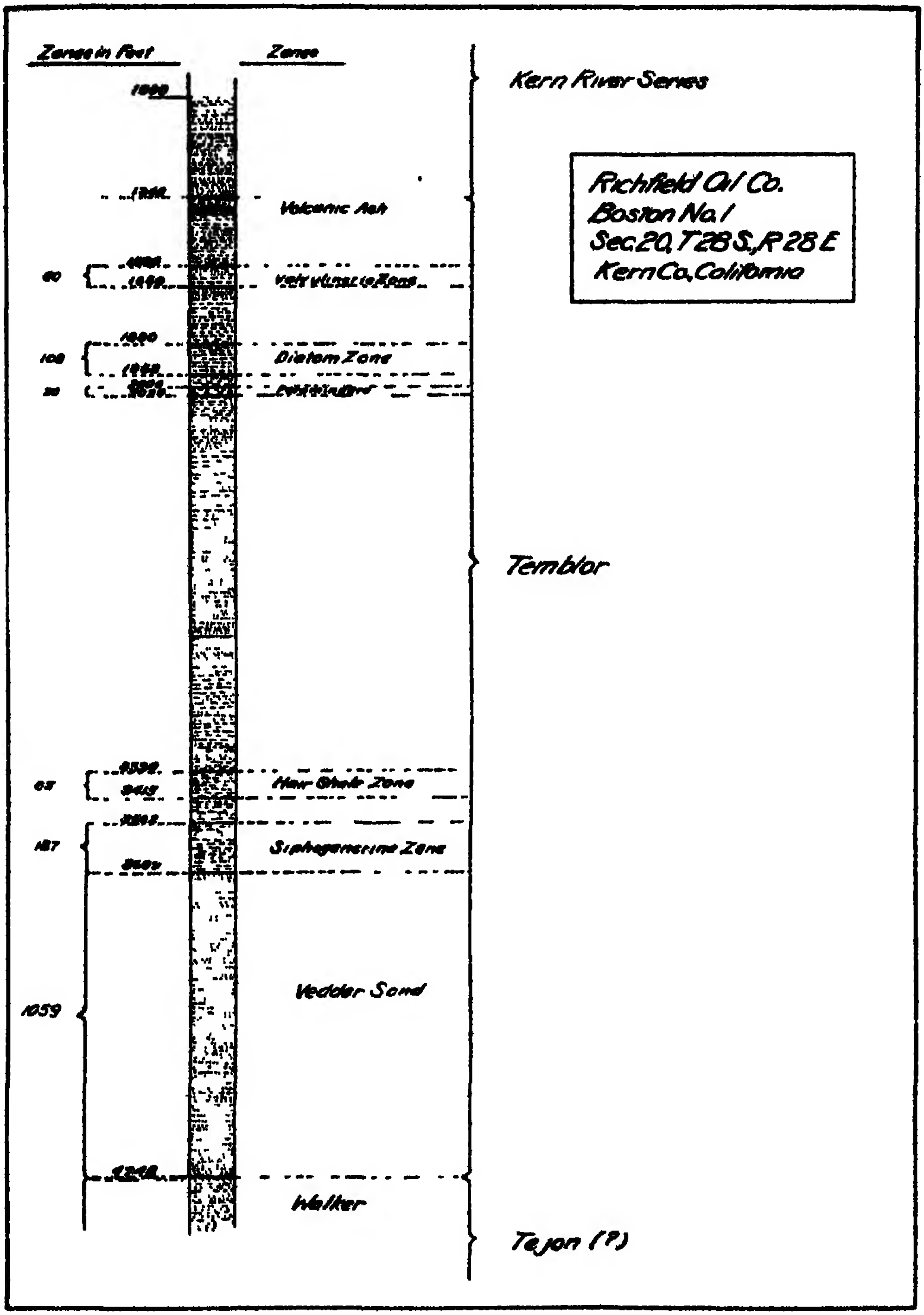

Fig. 2. Section shown in drilling Richfield Oil Company Well, Boston No. 1, near Sharktooth Hill.

Part of the difficulty has arisen from the supposed existence of Santa Margarita at Comanche Point at the south end of the valley. A very considerable collection of mollusca has been made there for the Academy and this has been critically examined by Messrs F M Anderson and L. G. Hertlein. They advise that the large oyster found in the collection is not *Ostrea titan* and the pecten is not *Pecten crassicardo*. The original determination was based on the supposed presence of these two species. The collection contains several species not yet known from upper Miocene or later deposits any place in California.

General Correlations

An attempt will not be made here to give a chronological account of the various efforts which have been made to correlate this part of the Temblor with sediments widely distributed elsewhere. It is believed the needs of the present study will be fulfilled by presenting the conclusions reached by those who have most recently taken up the subject.

Dr W P Woodring[15] in 1928 in a comprehensive study of the Mollusca of Bowden, Jamaica gave a large number of Miocene correlations and these have much wider application than can be inferred from the title of the paper. Regarding the Temblor he stated (p 98)

> "By means of this indirect comparison and relying for the most part on the admittedly slender evidence of one phylum of Turritellas it is concluded that the Bowden formation is about the same age as the Temblor formation, or as the upper part of the Temblor formation."

He placed the Bowden in the upper Middle Miocene, the equivalent of the Tortonian of the European standard time scale (p 39). On another page (p 94) the Calvert formation of the Chespeake Bay area is likewise correlated with the Tortonian, chiefly on the basis of studies of the plants and marine mammals by Berry[16] and Kellogg[17] respectively.

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[15] Woodring, W P. Miocene mollusks from Bowden, Jamaica. Pt. 2 Gastropods and discussion of results. Carnegie Inst Washington, Publ 385, 1928, pp. 1 564, pls. 1 40, 2 text figs.

[16] Berry, E. W U S Geol Surv Prof. Ppr 98-F, 1916, pp 61-70.

[17] Kellogg, R. Bull Geol Soc. America, vol. 35, 1924, pp. 763-764

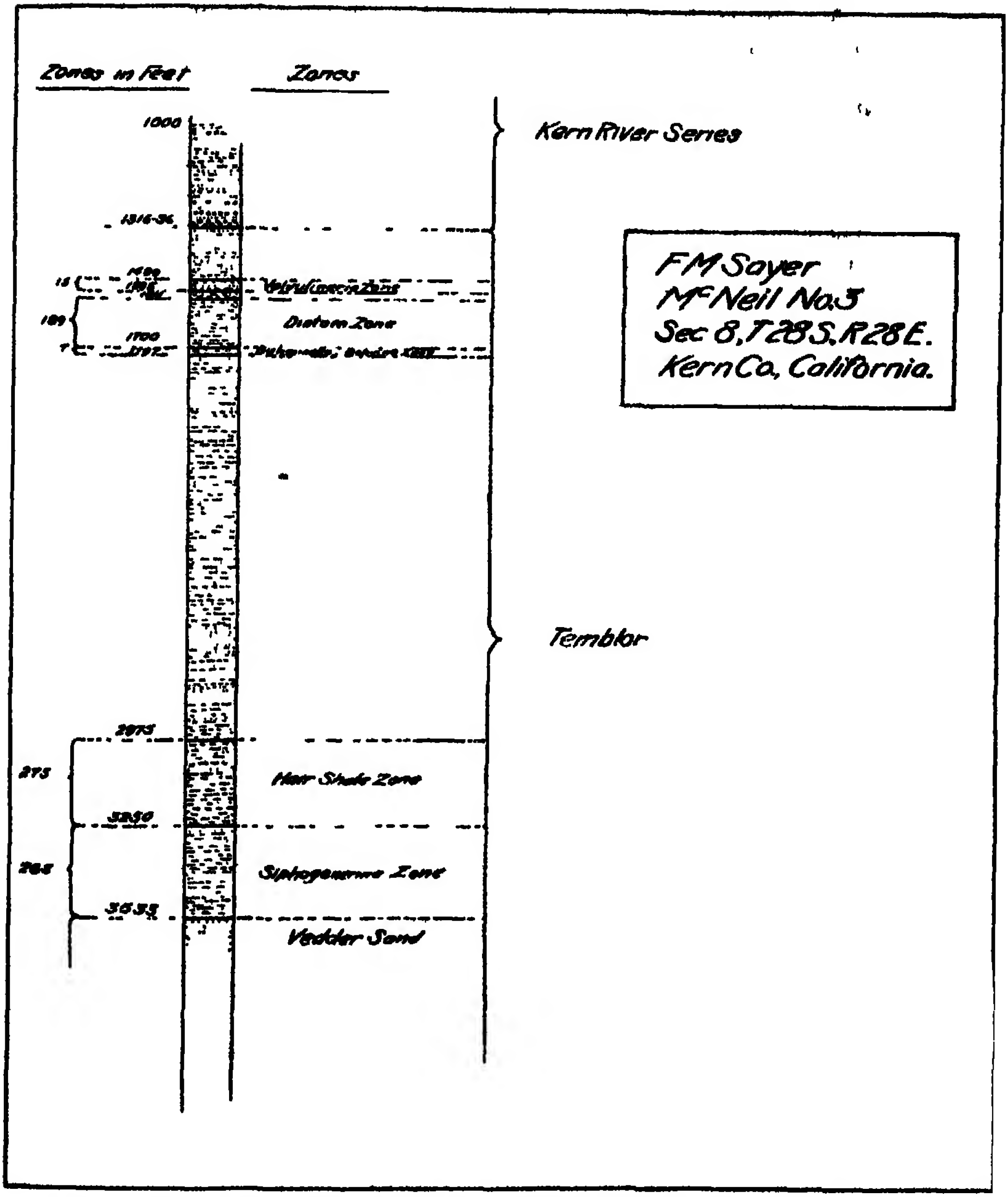

Fig. 3. Section shown in drilling F M Sayer Well, McNeil No 3, near Sharktooth Hill

My own study of the diatoms found in marine sediments a few feet below the stratum which yielded the mammalian remains investigated by Kellogg, indicate very clearly that this deposit must be very nearly the exact time equivalent of that portion of the Calvert formation which likewise contains fossil diatoms The number of specialized species of short geologic range is too large for any other conclusion to be reached Therefore if the Calvert formation be Tortonian then the upper part of the Temblor in the Kern River region should likewise be Tortonian.

Since the correlation of the Bowden beds with the Calvert and Temblor on the basis of mollusca was admittedly not positive there is the possibility that both may perhaps be the equivalent of the Helvetian of Europe This has been suggested by Kellogg[18] from a study of certain marine mammals I am inclined to favor this determination on stratigraphic grounds as well as from investigation of the diatoms. It is reasonably certain now that the upper part of the Monterey shale, widely distributed in California is the time equivalent of diatomites of Europe and Africa which have been placed in the Sarmatian The time interval between upper Monterey and upper Temblor was sufficient to permit the accumulation of at least 5000 feet of thinly bedded shales This seems too long for the two formations to be considered adjacent although there appears to be continuous deposition from the lower to the higher in many places in California. It seems plausible that the equivalent of the Tortonian may come between upper Monterey and upper Temblor

Under any circumstances the conclusion seems unavoidable that the upper Temblor is middle Miocene, there is a preponderance of evidence to this effect. It may be added further that several species of diatoms occur in the California formation which have already been found in Italy in sediments definitely called middle Miocene by Forti.[19]

If the conclusion be correct that the upper Temblor is Helvetian and the upper Monterey is Sarmatian, the California equivalents of the standard European Miocene section conveniently fall as follows·

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[18] Kellogg, R. Carnegie Inst. Washington, Publ. 346, art. 1, 1927, p. 5

[19] Forti, A. Atti R Inst Veneto, Sci. Lett Art vol. 72, 1913, pp. 1535-1790, pls. 14 29

CORRELATION OF CALIFORNIA AND EUROPEAN MIOCENE

SECTION	EUROPEAN STAGES	CALIFORNIA FORMATIONS
Upper	Pontian	Santa Margarita
Miocene	Sarmatian	Upper Monterey
Middle	Tortonian	Lower Monterey
Miocene	Helvetian	Upper Temblor
Lower	Burdigalian	Lower Temblor (Pyramid Hill fauna)
Miocene	Aquitanian	Vaqueros

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CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XIX, No. 8, pp. 85-93, 7 text figures JULY 15, 1930

VIII

FOSSIL BIRD REMAINS FROM THE TEMBLOR FORMATION NEAR BAKERSFIELD, CALIFORNIA

BY

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Collections of fossils made by Mr. Charles Morrice in the Temblor deposits of the Miocene near Bakersfield include several bones of birds that are of considerable interest in adding to our scanty information of the rich avifauna of the latter part of the Tertiary from an entirely new area. The specimens in question from information obtained through Dr. G. Dallas Hanna, and Dr. Remington Kellogg, were collected in 1924 by Mr. Charles Morrice in a stratum of unconsolidated sandy material exposed on the slopes of an eminence known as Sharktooth Hill west of Round Mountain, four miles east of the Kern River oil field, one-half mile north of Kern River, and about seven miles northeast of Bakersfield, Kern County, California. The exact location is on the north side of Kern River in Sec. 25, T. 28 S., R. 28 E., M. D. M. The elevation of the hill is given on the Caliente sheet of the U. S. Geological Survey's Topographic map as 642 feet above sea-level, but the hill on the map in question is not there named. The deposit which is in the uppermost fossil horizon of the Temblor Miocene has furnished many bones of marine vertebrates, consideration of which has led Dr. Kellogg to

believe that the beds are equivalent in age to the Helvetian stage of the European Miocene A study of the diatoms exposed in a stratum a few feet below the bone bearing layer has indicated to Dr. Hanna that the age there may likewise be the equivalent of the Helvetian of the European Miocene

The first of the bird bones received, the gannet, was sent to me some time ago by Dr Loye Miller for an opinion as to its generic allocation, followed by the request that I describe it The specimens of *Puffinus* come through Dr G Dallas Hanna from the California Academy of Sciences, and the remaining material was placed in my hands by Dr Remington Kellogg The collection, though small, contains three species new to science

The booby and the two shearwaters identified among the birds are of groups of distinctly marine habit, so that it seems logical to suppose that the goose was a form of similar preference in range

Drawings illustrating these specimens have been made by Mr Sydney Prentice

Family PROCELLARIIDÆ

1 **Puffinus inceptor** Wetmore, new species

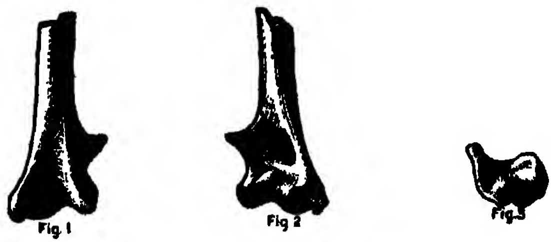
Characters—Similar to the modern *Puffinus tenuirostris*[1] (Temminck) but smaller, radial and ulnar trochleæ relatively smaller, incisura capitis more open, ectepicondylar process relatively more slender

Description—Type (figs 1-3), lower portion of right humerus, Calif Acad Sci No 5223, from the upper level of the Temblor Miocene on **Sharktooth Hill, about seven miles northeast of Bakersfield, Kern County, California,** in Sec 25, T 28 S R 28 E, M D M, collected in 1924 by Charles Morrice

Shaft obliquely flattened so that it is an elongate ellipse in outline, ectepicondylar process an acute triangle in general outline, thin, with upper margin forming a right angle with the longitudinal axis of the shaft, and lower margin sloping

[1] *Procellaria tenuirostris* Temminck Planch Col, vol 5, 1835, text for pl 587

upward at a forty-five degree angle with the same axis, in dimension relatively small as compared with modern shearwaters, depression for brachialis inferior roughly elliptical, deeply impressed, with sharply defined outline, entepicondylar process slight, merging with shaft at level of distal margin of ectepicondylar process, radial condyle relatively small, outer



FIGS 1-3.—Three views of type of *Puffinus inceptor*, natural size

surface flattened, ulnar condyle likewise relatively small, narrow, with free margin compressed, bladelike, descending at a right angle to join lower end of shaft, intertrochlear sulcus broadly open, in form a right triangle at bottom. Bone dull brown in color, well fossilized.

Measurements.—Transverse breadth across trochlea 12.2 mm., transverse breadth of shaft 5.9 mm., height of ectepicondylar process 4.6 mm., breadth of ectepicondylar process at base 4.6 mm.

Remarks.—Though in the diagnosis the present form is compared with *Puffinus tenuirostris* in relative proportions of trochleæ and ectepicondylar process, and in the breadth of the intertrochlear sulcus, it differs in the points indicated from all the modern shearwaters examined. In size, *inceptor* is near the wedgetailed shearwater, *Thyellodroma cuneata*. It is larger than the fossil *Puffinus diatomicus* L. H. Miller, from the Lompoc Miocene of California, and smaller than *Puffinus conradi*, described from a specimen from the Calvert Miocene of Maryland, and *Puffinus eyermani* Shufeldt, from the Pleistocene of Sardinia.

The type specimen of *P. inceptor* includes approximately the distal fourth of the humerus, with the shaft somewhat broken, and a little wear on the trochlea but otherwise complete

With description of the present form there are known three species of shearwaters from the Miocene of North America *Puffinus conradi* Marsh, Calvert formation of Maryland, *Puffinus diatomicus* L H Miller, Lompoc of California; and *Puffinus inceptor* Wetmore, Temblor of California

As three sizes and types are represented in this series of species it appears that the group comprised in the shearwaters was as well diversified in the seas of the Miocene as it is over our modern oceans

The study of *Puffinus inceptor* has led to consideration of the fossil species of this group known for the entire world and has brought to attention the name *Puffinus arvernensis* which is given by Alphonse Milne-Edwards in the work entitled Recherches anatomiques et paléontologiques pour servir a l'histoire des Oiseaux Fossiles de la France, vol 2, 1870, p 572, with the statement "Cette espèce, ayant été découverte depuis la publication du chapitre relatif aux oiseaux fossiles de cette famille, sera decrite et figurée dans un travail supplémentaire " There is no description here, so that it remains as a *nomen nudum* It seems to have been overlooked, however, that Dr R W Shufeldt, in describing *Puffinus eyermani,* in the Proceedings of the Academy of Natural Sciences of Philadelphia, December 8, 1896, p 511, plate 24, figs 1-2, has definitely named *Puffinus arvernensis* According to Shufeldt (l c p 510) he wrote to Prof Milne-Edwards to ask concerning the identity of *P arvernensis*, and the latter under date of July 9, 1896, sent him a drawing of the metatarsus of that species, saying that it came from St Gerand le Puy, and giving Shufeldt permission to use it as he saw fit This drawing Dr Shufeldt published in the paper cited above, and in addition identified a tibio-tarsus, two humeri and a coracoid from Sardinia as probably that species On the basis of Shufeldt's published figure of the metatarsus, this species is here identifiable, and will stand therefore as *Puffinus arvernensis* Shufeldt, to be cited from Dr Shufeldt's paper

2 Puffinus sp

With the type of *Puffinus inceptor,* there was found part of a right humerus, California Acad Sci No 5224, that represents a species of *Puffinus* This specimen comprises a little less than the distal half of the bone with the ectepicondylar process broken away but otherwise with little wear In size of the articular portion this bone is similar to the modern *Puffinus creatopus,* but the shaft is much heavier, being about the dimension of that of the living *P gravis* On comparison with the type specimen of *Puffinus conradi,* described from the distal part of a left humerus from the Calvert formation of the Miocene of Maryland, the fossil here under discussion is found to agree with remarkable closeness in its conformation, differing principally in slightly smaller dimension In view of its fragmentary condition there is little more that may be said regarding the Temblor specimen except to state from the fragment at hand it is apparently of a form closely allied to *P conradi* of the Miocene of the east coast

Following are dimensions of the California fossil: transverse breadth of distal end 12 8 mm , transverse diameter of shaft 6 9 mm For the type of *P conradi* these measurements are 13 4 and 7 1 mm respectively

Family SULIDÆ

3 **Moris vagabundus** Wetmore, new species

Characters —Similar in form to *Moris serrator* (Gray)[3] but decidedly smaller

Description —Type, (fig 4), distal end of right humerus, Univ Calif Mus Pal Cat No 31062, from the upper level of the Temblor Miocene of **Sharktooth Hill, about seven miles northeast of Bakersfield, Kern County, California,** in Sec 25, T 28 S , R 28 E , M D M , collected in 1924 by Chas Morrice.

Lower end of shaft flattened, with broad impression for brachialis inferior, bordered externally by a low, rounded

[3] *Sula serrator* Gray, in Dieffenbach's Trav New Zealand, vol 2, App , January, 1843, p 20

margin, and internally by an abrupt plate that merges with the flattened, plane, narrowed, elongate pronator tubercle, a distinct cup-shaped depression below this tubercle, marked at upper side by a raised line anterior end of pronator tubercle very slightly elevated, ulnar condyle elevated and protrudent

Fig 4

Fig 4—Type of *Moris vagabundus*, anterior view, natural size

anteriorly, irregularly globular at under side where it projects as a ball, sloping rapidly externally as an elongate ridge, with a large open olecranal depression behind, radial condyle elongate, compressed, elevated, curved inward at upper end, where the outer side and tip are under cut, tendinal attachments on outer face pronounced Bone well fossilized, light brown in color

Measurements—Breadth across condyles 18 3 mm , vertical diameter of ulnar condyle 7 2 mm , vertical length of radial condyle 9 5 mm

Remarks—The present specimen while fragmentary exhibits the characters of the lower humerus that distinguish the gannets of the genus *Moris* from the boobies of the genus *Sula* in that the pronator attachment is elongate, narrow, and nearly plane and the olecranal depression is without pronounced overhang on its inner side, where there are a few small foramina In *Sula* the pronator attachment is shorter and is much rounded, and there is a very evident overhang on the inner side, with large easily evident foramina at this point

The species here described is similar in the fragment at hand in conformation to the three living species of gannets, i e *M bassana*, *M capensis* and *M serrator*, and likewise

resembles a broken humerus from the Miocene of Maryland that I have identified as *Moris loxostyla* (Cope),[3] but differs from all these in its smaller size. It is approximately as large as the living *Sula piscator*. The following measurements of the transverse breadth of the lower end of the humerus across the condyles will show the relation in size of *vagabundus* to the other known gannets: *M. bassana* 23.7-24.3 mm., *M. serrator* 22.5 mm., *M. capensis* 22.5 mm., *M. loxostyla* 21.1 mm., and *M. vagabundus* 18.3 mm.

A fragmentary ulna from the same locality (U. S. Nat. Mus. Cat. No. 11971) as the type of *vagabundus* is of the proper dimension to come from this same species and is so identified. It resembles the ulna in the modern species of *Moris* in conformation, being distinguished only by smaller size. The proximal end of the bone is entirely gone, about seven-eights of the specimen being present. The greatest transverse diameter of the shaft near its center is 7.4 mm. The transverse diameter of the distal end through the carpal ridge is 10.2 mm.

Sula willetti L. H. Miller[4] from the Miocene of Lompoc, California, is about the same in size as the species here described. Dr. Loye Miller has kindly forwarded to me his original photographs of *S. willetti* from which the characters of the skeleton are more easily evident than in the published plates. Differences of the humerus in *Moris* and *Sula* have been noted above. In the skull of *Sula* the ramphotheca of the bill extends back to the cranio-facial hinge, the surface of the bone anterior to this point being roughened and cut by innumerable small channels or canals. In *Moris*, where the feathering of the forehead extends well beyond the cranio-facial hinge, the bone beneath this feathering is smooth and even, the roughening beginning only with the portion covered by ramphotheca. The difference is definite and easily seen on examining specimens. In both skull and humerus *willetti* is a true *Sula* and so has no bearing in considering the specific distinctness of *Moris vagabundus*.

[3]See Auk, 1926, p. 465.

[4]Carnegie Inst. Washington Publ. No. 349, August, 1925, p. 112, pls. 3 and 8.

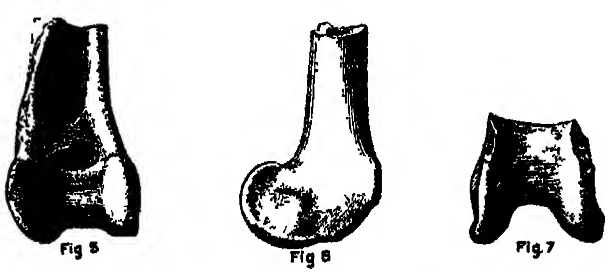
Moris vagabundus is the second true gannet now known from the Miocene, the other species *Moris loxostyla* (Cope) being represented in the Calvert formation of Chesapeake Bay, Maryland With its description there are known three living and two extinct species in this genus

Family ANATIDÆ

4 **Presbychen abavus** Wetmore, new genus and new species

Characters—Similar to *Branta canadensis* (Linnæus),[5] but lower end of tibio-tarsus with the tendinal bridge less oblique with relation to the axis of the shaft, raised border on inner side of anterior face of shaft relatively narrower, less rounded, and inner face of shaft at lower end less flattened, more rounded

Description—Type (figs 5-7), lower end of right tibio-tarsus, U S. Nat Mus No 11973, from the upper level of the Temblor Miocene on **Sharktooth Hill, about seven miles northeast of Bakersfield, Kern County, California,** in Sec 25, T 28 S, R 28 E, M D M, collected in 1924 by Charles Morrice



Figs 5-7—Three views of type of *Presbychen abavus*, natural size

Lower end of shaft strong, rounded on posterior surface and sides, broadly and deeply grooved anteriorly, this groove spanned at its lower end by a strong supra-tendinal bridge set at a very slight angle with the longitudinal axis of the shaft,

[5]*Anas canadensis* Linnæus, Syst Nat., ed. 10, vol 1, 1758, p 123

groove for peroneus profundus broad and open, inner anterior raised margin above anterior groove relatively narrow, raised as a rounded ridge, internal condyle elongate, produced farther anteriorly than external condyle, with a raised margin when viewed externally, and a broad, low, central tubercle, external condyle smaller, and more rounded, intercondylar sulcus broad and open, with a deep intercondylar fossa on anterior surface, angular at the bottom, from which there is gradual slope toward the external condyle, and more abrupt slope toward the internal condyle, the external walls being thicker, sulcus broadly open in front, with bottom rounded Bone light brown in color, cracked but skillfully repaired, well fossilized

Measurements — Transverse breadth across condyles 18 6 mm, transverse width of external condyle about 16 8 mm. transverse width of internal condyle 19 0 mm

Remarks—This form in general is strongly suggestive of the modern Canada goose, differing in the particulars noted above, and in much larger size, *Presbychen* being intermediate in dimension between the largest of Canada geese and the whistling swan The resemblance to living *Branta* is so strong as to suggest a bird of a form similar to that found in that group The species here described is of particular interest as the oldest species of anserine bird yet described from the Miocene of North America, *Laornis edvardsianus* Marsh[6] from New Jersey, formerly considered Cretaceous but now placed in the Eocene, being very doubtfully related to the Anseriformes

[6]Amer Journ. Sci, ser 2 vol 49, 1870, pl. 206.

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FOURTH SERIES

VOL. XIX, No 9, pp 95-104, 1 text figure JULY 15, 1930

IX

THE KILLIFISH OF SAN IGNACIO AND THE STICKLEBACK OF SAN RAMON, LOWER CALIFORNIA

BY

GEORGE SPRAGUE MYERS

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Field parties of the Museum of Vertebrate Zoology of the University of California have at times collected a few fishes in Lower California The trout obtained by Mr Chester C Lamb in the Santo Domingo River have been reported on by Prof J O. Snyder (1926), while the present paper records a stickleback and a killifish obtained by Mr Lamb in 1925 and 1927 Both have proved of considerable interest, due principally to our very fragmentary knowledge of the fish fauna of the peninsula.

Fundulus lima Vaillant

Fundulus lima Vaillant, 1894, p 71, San Ignatio
Fundulus meeki Evermann, 1908, p 25, fig. 1, San Ignacio
Fundulus lima Myers, 1927, p 178

Two killifishes were collected by Chester C Lamb at San Ignacio, April 22, 1927 Both are males, the larger in breeding dress

This is the third occasion on which this fish has been taken at San Ignacio Vaillant's material was collected "à San

Ignatio de Caracamande (centre de la Sierra de la Basse-Californie), dans des bassins et mares de l'ancien établissement des Jésuites" by M. Léon Diguet in 1892 The types of Evermann's *Fundulus meeki* were taken by Dr E W. Nelson of the United States Biological Survey "from a small stream flowing from large springs at San Ignacio, Lower California," on October 8, 1905 Mr Lamb's collection forms the third one from San Ignacio

The present writer some time ago pointed out (Myers, 1927, p. 178) the identity of *F meeki* with *F. lima.* Shortly after the appearance of this note, Mr Carl L Hubbs *(in litt)* called the writer's attention to the similarity of *F. lima* and *F. parvipinnis,* the common killifish of the southern California coast, and suggested that the two might not be specifically separable No material was then at hand, however, and the question was dropped

Osburn and Nichols (1916, p 150, fig 5[1]) have described a deep-bodied race, *Fundulus parvipinnis brevis,* from Magdalena Bay, Lower California The writer examined the type series of this species in the American Museum of Natural History, New York, several years ago Comparison with series of *parvipinnis* from San Diego entirely upheld the status given the form by the original describers, for although the depth is in general considerably greater than in *parvipinnis,* some individuals were not to be distinguished from the more northern race by any of the measurements applied

Unfortunately there are no specimens of *brevis* now at hand for direct comparison with the two *lima* in the present collection Differences are seen in scale number, which are, however, bridged over by specimens of *parvipinnis* In general we may say that *lima* shows a tendency towards greater body depth and a more posterior dorsal origin than do the other forms The depth figures for *lima* are covered by those of *brevis* Unfortunately Osburn and Nichols do not give the fin positions in their material, and the figure, as has been noted, is not to be trusted The distances from dorsal origin to snout tip and from dorsal origin to end of hypural given for *lima* in the table are most nearly approached among the small series of *parvipinnis* measured by one which shows 60

[1]The figure is inaccurate in some of the proportions

and .42 respectively (All *parvipinnis* examined are from the coast of San Diego County, Calif.) Since this differs from the *lima* figures only in a very few hundredths, and since our sample of *lima* is so very small, it may be that an adequate series of either will show an overlap

Fundulus lima (Vaillant)

Fig 1 Scale from peduncle of breeding male *Fundulus lima*, greatly enlarged The dermal covering of scale and spine has been removed Photo by Mr Alan C Taft

Another character in which *lima* appears to differ appreciably from related forms is the extraordinary development of the ctenii of the scales of breeding males These ctenii are known to occur on many killifishes (Fowler, 1916) but the writer knows of no other case where they are so markedly developed The scales of practically all parts of the body have their free margins edged with one to four small spines, the central one being usually enlarged and the others reduced or absent in the scales of the sides of the body On the caudal peduncle, from between the dorsal and anal fins to the caudal base, this central spine is enormously enlarged, equalling the exposed portion of the scale in length Appearing much larger within their thick dermal covering, these projecting spikes give the male a most remarkable appearance Small prickles are

found along the rays of the dorsal and anal fins, these apparently being similar to those of other species of *Fundulus*. The ctenii of the scales are much less developed in the smaller male of the collection.

According to Newman (1909, p. 180) the ctenii or contact organs of breeding males of *Fundulus majalis* and *F. heteroclitus* disappear within eight weeks after spawning, and he believes this to be due partly to wearing off by friction in breeding and fighting and partly to resorbtion. Whether the same is true of the spikes of *lima* we may only surmise.

Males of *parvipinnis* are known to possess scale ctenii at breeding time but in the several small adult males available to me, there is no development comparable to that seen in the large *lima*. I can find no description of large adult males of *parvipinnis* in breeding dress.

The principal characters of the two specimens of *lima* are given in the table. The measurements of the relative distances of the dorsal origin from snout tip and from caudal base (end of hypural) are absolute and are not reduced to an ideal horizontal axis of the fish, as are the others. It will be noted that the transverse scale counts given by Vaillant and by Evermann are widely different. While this may be due to Vaillant having counted from the mid-ventral series instead of from the pelvic fin, it is more likely caused by the crowded small scales present at the bases of the anal and dorsal fins in some specimens. Our large male thus has transverse scales 19 while the smaller one has but 16. The scales of the anterior sides of *lima* are very large; posteriorly they grow somewhat smaller, while on the breast and abdomen they are greatly reduced in size. The origin of the anal is a little anterior to the vertical of the dorsal fin origin. The pectorals do not extend quite so far as shown in Evermann's figure, and the pelvics are rather reduced.

The color of the large male is very dark, the whole body being blackish save for a number of scattered light-centered scales. The fins, including pectorals, are blackish with light borders. The smaller male is much lighter and has the typical horizontal dark streak with suggestions of short cross-bands seen on the posterior sides of *parvipinnis*.

Neither of the males shows any tendency towards the production of the elongate anal fin typical of male *parvipinnis*, so well figured by Steindachner (1876, pl X). This seems to be an important difference, but it may be bridged over by *brevis*.

At the present time it cannot be shown that *lima* and the forms of *parvipinnis* intergrade, although it is possible that they do The position of the dorsal, the shape of the anal fin of the male, and the peculiar scale formation in this sex must serve as distinguishing characters until more material is available

Fundulus lima is evidently a more or less isolated geographic derivative of *F parvipinnis*, but whether of the *brevis* or of the *parvipinnis* stock, or of either as they at present exist, we cannot say Evermann (1908, pp 20-21) tells us that the stream at San Ignacio loses itself in the sand some 10 to 12 miles from the springs which are its source, but that in rainy seasons it sometimes reaches the coast Whether at such times it is ascendable by coastal *Fundulus* we do not know Probably it is not, and the San Ignacio killifish has been isolated for a considerable period

It would be interesting to have data on the scales of spawning male *parvipinnis*, and on the extent to which this species enters wholly fresh water Further collections from many localities on the peninsula are necessary before the relationships of *Fundulus parvipinnis parvipinnis* to *F p brevis*, and of both to *F lima* can be clearly ascertained

Gasterosteus aculeatus (Linnæus)

There are nine specimens of a stickleback collected by Chester C Lamb at San Ramon, mouth of the Santo Domingo River, on December 26, 1925 All of them possess three plates in contact with the ascending pelvic process[4] but lack all plates behind these as well as the keel of the peduncle For other data the accompanying table may be consulted

The sticklebacks, particularly the three-spined ones of the genus *Gasterosteus*, are exceedingly variable creatures Specimens taken in the Arctic Sea and other northern points are very large, with fully mailed sides and a distinct peduncular

[4] In specimen VI the third is absent on one side

keel Travelling southward, the animals gradually become smaller, begin irregularly to lose their plates, and the keel disappears Southward they are less and less marine, more estuarian and fluviatile in habits Those living further upstream tend to have fewer plates, while in at least one stream of southern California, the Santa Ana, almost the whole population is entirely unmailed

Many writers have discussed the variations of West Coast sticklebacks Rutter (1896) has prepared tables of variations of 2296 specimens from Oregon to "Rio Salado, Mexico." Jordan and Gilbert (1899, p 443) have discussed variations of Alaskan and more southern material Evermann and Goldsborough (1907, p 273) have further discussed Alaskan sticklebacks Snyder (1908, p 184) has tabulated variations of numerous individuals from Oregon and northern California

Regan (1909, p 437), apparently ignoring this literature, has attempted to show that the naked sticklebacks of the Santa Ana and all to the south,[8] are specifically distinct from the form of the Santa Clara River and all to the north of it Snyder (1913, p 71) has shown that in the lack of armature at least, the Santa Ana form is not constant, but up to the present no one (save Jordan and Hubbs, 1925, who give no data) has seriously questioned the adequacy of the vertebral counts used by Regan as his principal diagnostic character

In the tabulated vertebral counts for the San Ramon sticklebacks the writer has counted the hypural (*i e*, the last centrum, with the expanded hypural processes and urostyle) as one Regan appears not to have included the hypural The variation from 30 to 32 in five of the San Ramon specimens disposes of Regan's contention that the southern sticklebacks may be distinguished by a reduced number of vertebræ

There seems no reasonable doubt, however, that Regan's conclusion concerning the specific identity of the stickleback of the North Pacific, *G cataphractus*, with that of the North Atlantic, *G aculeatus*, is sound Jordan and Hubbs (1925, p 201) propose to recognize three subspecies of Pacific sticklebacks, *G aculeatus aculeatus* in the far north, *G. a microcephalus* south of this and along the coast apparently as far south as the species extends, and *G. a williamsoni* (equals

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[8]Regan, *loc cit*, p 436

G santæ-anæ Regan) in the Santa Ana River This arrangement must be supported by a very large mass of evidence before it can be adopted We have referred above to the fact that, in California at least, the sticklebacks found up-stream are likely to be less completely mailed than those in tide water and this fact alone will necessitate a very careful analysis of the various populations It must be shown, furthermore, that there are fairly distinct northern and southern groups with a more or less definite area of intergradation instead of an evenly graded series of forms from Alaska southward, before the subspecies *microcephalus* may be accepted And lastly there is the question of the status of the specimens south of the Santa Ana.

The present material is merely referred to *aculeatus* Other sticklebacks have been reported from northern Lower California, by Rosa Smith (1884, p 233) and by C H Eigenmann (1892, p 144), but unless the "Rio Salado" of Rutter is below San Ramon, the specimens of the present collection appear to be the most southerly obtained

NOTE

It apparently has not been noticed that the trout of the Santo Domingo River (see Evermann, 1908, and Snyder, 1926) were first made known through four specimens collected by Edmund Heller in 1902 and recorded by Meek (1904, p 96) as *Salmo irideus*

Fundulus lima

Specimen	Standard length	Lengths in hundredths of standard length							Dorsal	Anal	Lat. line
		Head	Depth	Eye	Caudal peduncle		Dorsal origin to				
					Depth	Length	Snout tip	End hypural			
I	79 mm	29	32	05	16	22	64	37	11½	11½	36+3
II	63 5 mm	30	30	07	15	24	66	36	11½	12½	35+3

Gasterosteus aculeatus

Specimen No	Standard length in mm	Head length in mm	H. L. in hundredths of standard length	Dorsal	Anal	Vertebræ, counting hypural
I	30	10	33	II I 11	I 9	31
II	29 5	9 5	32	II I 10	I 8	30
III	25	8	32	II I 11	I 7	32
IV	28	8 5	30	II I 12	I 8	31
V	33	10 5	31	II I 12	I 9	30
VI	27	8	30	II I 12	I 8	—*
VII	27	8 5	31	II I 11	I 9	—
VIII	29	10	34	II I 12	I 9	—
IX	37 5	12	32	II I 12	I 8	—

*Not examined in last four specimens

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PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL XIX, No 10, pp 105-108 JULY 15, 1930

X

CONTRIBUTIONS TO ORIENTAL HERPETOLOGY

IV. HOKUSHU OR YEZO

BY
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Although Hokushu or Yezo Island is second in size of those which constitute Japan proper, it has but a small amphibian and reptile fauna The species of Sakhalin seem not to have reached Hokushu, with the possible exception of *Rana temporaria* Most of the species are identical with the reptiles and amphibians of Honshu or Hondo Island, and there can be little doubt that these two islands have been connected Dunn regards the salamander of this island as distinct from any of the species of Hondo It seems probable that *Triturus pyrrhogaster* does not occur on Hokushu and that *Bufo bufo prætextatus* does, though neither the absence of the one nor the presence of the other is yet certain *Eumeces, Natrix, Agkistrodon,* and *Elaphe climacophora,* are not included in our Yezo collections.

1 **Hynobius retardatus** Dunn

Our 11 specimens have been studied and recorded by Dunn [1] They are two (Nos. 35927 and 35928) from Noboribetsu, Iburi Province, collected August 30, 1911, of which No 35928 is the type, one (No 25990) collected at Nemuro, Nemuro Province, and eight (Nos 25982 to 25989) secured at Sapporo, Ishikari Province

2 **Bufo bufo prætexatus** (Boie)

One young toad (No 26067), measuring 18 mm from snout to vent, seems not to differ from specimens from Hondo, but, of course, it is too small to be of much value It is labeled Sapporo, Ishikari Province, 1910, with a note that this locality is not to be relied on I presume that this note refers to Sapporo rather than to the island itself, but the presence of a toad on Hokushu cannot yet be positively affirmed

3 **Hyla aborea japonica** Gunther

Twenty-five specimens of this tree-toad were collected on this island in 1910 I have been unable to find any difference between these specimens and others from Hondo They were secured at the following localities

26042	Fukuyama, Oshima Province.
26043 to 26044	Hakodate, Oshima Province
26045 to 26059	Kikonai, Oshima Province
26060 to 26064	Sapporo, Ishikari Province
26065 to 26066	Otaru, Shiribeshi Province

4 **Rana temporaria** Linnæus

All of our 19 frogs from Yezo belong to this species No 25991 has the snout somewhat longer and the web smaller than the others, but as this may be individual variation, I have not referred it to *Rana japonica*. There is a good deal of variation in the size of the inner metatarsal tubercle and in the

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[1] Proc Amer Acad Arts and Sci., LVIII, No 13, pp. 476-479

position of the vomerine teeth The teeth are mostly between the choanæ in 16012, 25994, 25995, 26002, 26040, and 26041, between and behind in 25998, 25999, 26001, 26003, and behind in 25991, 25992, 25993, 25996, 25997, 26000, 26004, 26005, and 26733. The outer metatarsal tubercle is present in 16012, 25998, 25999, 26001, 26002, 26003, 26004, and 26041; it is absent in 25991, 25992, 25993, 25994, 25995, 25996, 25997, 26000, 26005, 26040, and 26733 The dorsolateral glandular ridge flares out anteriorly toward the tympanum in all of these nineteen specimens The throats are without definite dark spots The specimens were collected as follows

16012	Hakodate, Oshima Province
25991 to 25998	Otaru, Shiribeshi Province, 1910
25999 to 26002	Mororan, Iburi Province, 1910
26003 to 26005	Sapporo, Ishikari Province, 1910
26040	Otaru, Shiribeshi Province, 1910
26041	Fukushima, Oshima Province, 1910
26733	Hakodate, Oshima Province, September 15, 1910

5 **Takydromus tachydromoides** (Schlegel)

Fourteen lizards of this species from Yezo seem not to differ from those secured on Hondo They are from three localities, as follows

25967 to 25970.	Kikonai, Oshima Province, 1910
25971 to 25976	Otaru, Shiribeshi Province, 1910.
25977 to 25980.	Sapporo, Ishikari Province, 1910.

6 **Elaphe quadrivirgata** (*Boie*)

We have five snakes of this species from Yezo, where they were collected as follows

25981	Sapporo, Ishikari Province, 1910
26728 to 26729	Mororan, Iburi Province, September 10, 1910
26730 to 26731	Kikonai, Oshima Province, 1910.

No. 25981 is jet black everywhere except on the labials, chin and throat. The others are of the usual light coloration The scale counts are given below

No.	Sex	Scale Rows	Gastro-steges	Urosteges	Anal	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Temporals
25981	♀	19	191	75c	2	8–8	10–10	2–2	3–3	2+3–2+3
26728	♀	19	193	75c	2	8–8	10–10	2–2	2–2	2+2–2+2
26729	♀	19	199	81c	2	8–8	10–10	2–2	2–2	2+3–2+3
26730	♂	19	203	88c	2	8–8	10–10	2–2	3–3	2+2–2+2
26731	♂	19	201	86c	1	8–8	10–9	2–1	2–2	2+3–2+3

If we combine with these figures the counts given by Dr Stejneger of three Yezo speciments, we get the following averages· Gastrosteges. four males 200 7, three females 194.3, 1 juvenile 198; eight specimens 198 Urosteges four males 85; three females 77, 1 juvenile 78; eight specimens 80 The average counts for the other Japanese islands are higher, those of Hondo being Gastrosteges nineteen males 205, eighteeen females 203 2, thirty-seven specimens 204 2. Urosteges. fifteen males 87 6; eighteen females 82 1; thirty-three specimens 84 6 If larger series from Yezo confirm these figures, it may be best to use the name *Elaphe quadrivirgata bilineata* (Hallowell) for the snakes of Yezo

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XIX, No. 12, pp 217-397, 134 text figs JANUARY 30, 1931

XII

PELAGIC MAMMALS FROM THE TEMBLOR FORMATION OF THE KERN RIVER REGION, CALIFORNIA

BY

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This paper presents the results of studies on fossil pelagic mammals from the Temblor formation which outcrops on a hill southwest of Round Mountain, locally known as Sharktooth Hill, and about seven miles northeast of Bakersfield, four miles east of the Kern River Oil Field, and a quarter of a mile north of Kern River, Kern County, California. This hill is located in Sec 25, T 28 S, R 28 E, M D M, and is shown but not named on the Caliente sheet of the United States Geological Survey's topographic map The greater part of the material studied belongs to the California Academy of Sciences and was assembled largely through the active interest of Messrs Paul Shoup and M E Lombardi To Dr Barton Warren Evermann and Dr G Dallas Hanna, the writer is indebted for permission to study the collection

Prior to the assembling of this collection, several smaller lots, obtained by Mr Charles Morrice, were presented to the United States National Museum Detailed descriptions of specimens in both of these collections are herewith given. Through the cooperation of the Carnegie Institution of Washington, arrangements were made for transporting the Academy's collection to Washington, D C, and that organization provided additional funds for illustrating the more im-

portant specimens For carrying out the latter purpose, the services of Mr Sydney Prentice were secured, and he has prepared the line drawings that accompany this report

Excavations made on Sharktooth Hill in 1924 under the direction of Doctor Hanna and Mr Morrice, yielded something like a thousand bones, the majority of which were so damaged and imperfectly preserved that they were discarded. Most of the bones are more or less incrusted with a psilomelate of manganese They occur in a fairly coarse, light gray, firm sandstone, and it is rather surprising that so many of them were broken prior to excavation. No associated skeletons were found, and it would seem that the skeletal elements were disassociated prior to their being covered with the sediments in which they are now found No satisfactory explanation of the conditions that led to the accumulation of these bones has as yet been set forth According to Doctor Hanna[1] "the bones occupy a stratum not over three feet thick so that the extinction of the excessively abundant species must have occurred in a very short time The wide extent of the deposit does not indicate that the animals were trapped in a narrow bay as sometimes happens today with whales and sharks" Dr F M. Anderson[2] has suggested that an epoch of violent volcanic activity and fall of ash may have been responsible for the death of large numbers of pelagic animals in the Temblor Sea, but such an explanation does not satisfactorily account for the scattering and mingling of bones of many species of animals Under such conditions one would expect to find complete, associated skeletons buried in ash and other sediments in the positions in which they perished Poisonous volcanic gases and inorganic materials may have caused the death of the Temblor animals, but some agency other than volcanic activity must have been responsible for scattering the remains. It is possible that the conditions of deposition at the Sharktooth Hill locality may have paralleled present conditions near Surf, California. The rush of the water at that locality would tear any skeleton apart. Critical study of this collection has led the writer to believe that some of the bones may have decayed before fos-

[1] G D Hanna, Miocene marine vertebrates in Kern County, California <Science, n s., vol. 61, no. 1568, pp. 71 72, January 16, 1925

[2] F M Anderson, The Neocene Deposits of Kern River, California <Proc. Calif Acad Sci, Ser 4, vol 3, p 102, 1911.

silization took place From this it may be inferred that the bones were washed about before they were finally covered with sediments. Bones of cetaceans are usually quite porous and the cavities are filled with small globules of oil Bacteria and other organisms thrive in these bones and under certain conditions disintegration results On the other hand, bones of pinnipeds are generally less porous than those of cetaceans and this may account for their better preservation Unusually large numbers of sharks abounded in the Temblor Sea and pelagic mammals undoubtedly suffered from their predatory proclivities The skeletons of their prey would be dismembered and the bones scattered Nevertheless, teeth of sharks are by far the most abundant fossil remains found at this locality, and it would seem that they perished in enormous numbers at about the same time as the pelagic mammals Further study of the Temblor formation, particularly the bone bed, may lead to some rational explanation of the conditions that resulted in the accumulation of this varied fauna at one particular level in the formation The fact that many of the bones are fractured and the cavities filled with gypsum would seem to indicate violent diastrophic activity subsequent to their burial, and that the resulting cracks were later cemented by the salts carried in solution by percolating water

This bone bed is included in Anderson's zone "C," but it is not the uppermost fossil horizon, for above it lies a poorly preserved fauna of invertebrates, and below it are the very fossiliferous strata from which were obtained most of the Temblor mollusca described by Anderson and Martin Likewise below there is a widespread zone of diatomite and several zones of characteristic foraminifera The bone bed is located a short distance below the unconformity which in the Kern River region separates strata of uncertain age, known as the "Kern River Group," from the underlying Temblor formation The beds dip to the westward at an angle of about 5 degrees, and the strike is approximately north and south.[3a]

The Temblor fauna includes primitive whalebone whales (cetotheres), delphinoid porpoises, a squalodont, a sperm whale, two pinnipeds, *Desmostylus*, a sea turtle allied to the

[3a] For an account of the geology of the region see G D Hanna, Geology of Sharktooth Hill Proc Calif Acad Sci., ser 4, vol 19, 1930, pp 65-83, 3 text figs.

recent green turtle, and at least three birds.[8b] So little is known in regard to the geological history of the pinnipeds that they must be disregarded for purposes of time correlation. Nevertheless, *Allodesmus* is quite distinct from the sea lion of the diatomaceous series at Lompoc and unquestionably represents a more generalized type, while the Lompoc animal corresponds rather closely in most details with the recent *Eumetopias* The peculiar pelagic *Desmostylus* and the cetotheres correspond in specialization with other types found elsewhere in Miocene formations, but the sperm whale is quite unlike any other described physeteroid It is also true that none of the long beaked porpoises of the Miocene are represented in the material thus far collected, but one of the contemporary squalodonts is present The delphinoid porpoises add little information in regard to the age of this deposit Although our present limited knowledge of these animals adds very little conclusive evidence in regard to the age of the Temblor formation, it is unquestionably the largest fauna of pelagic mammals thus far known for any Tertiary formation on the Pacific Coast of North America There is some slight evidence in favor of regarding the Temblor fauna as of middle Miocene age In the cast of cetaceans, we are dealing with a type of specialization which shows the cumulative effects of modification, and the telescoping of the bones in the skull affords a means of determining the stage in their general advance The stages represented by the Temblor cetothere skulls and the physeterid skull are what we should expect to find in middle Miocene formations

Toward the close of the Oligocene and in early Miocene times, we find a few survivals of archaic types, but the bulk of the cetaceans are more advanced than their predecessors There are, in the lower Miocene, at least five recognizable families of toothed whales which are known as squalodonts, long beaked porpoises, short beaked porpoises, beaked whales, and sperm whales The whalebone whales are represented by the cetotheres and a primitive balaenid A wider diversification of the prevailing types seems to characterize the middle Miocene faunas On analyzing the late Miocene faunas, we note

[8b] For a description of these birds see A Wetmore, Fossil bird remains from the Temblor formation near Bakersfield, California. (Proc Calif Acad. Sci., ser 4, vol 19, no 8, 1930, pp 85 93, 7 text figs.)

a perceptible reduction in the number of long beaked types, the disappearance of the squalodonts, the appearance of advanced types of beaked whales (ziphioids), the appearance of the larger, modernized whalebone whales, and a tendency toward the elimination of the true cetotheres In Europe and elsewhere, we observe that these modernized types make their appearance toward the close of the Miocene period, coincident with the reduction and extinction of the types that preceded them. In the diatomaceous series at Lompoc, California, a more modernized assemblage than that of the Temblor makes its appearance, and the writer is inclined to refer that fauna to the later part of the Miocene During the Pliocene, typical whalebone whales become more numerous, the short beaked porpoises are similar to living types, the beaked whales (ziphioids) belong to living genera, and, in the early Pliocene Parana formation of South America, a few new types of long beaked porpoises represent the only known survivors of that line of development

Order SIRENIA

Suborder Desmostyliformes Hay, 1923

Family DESMOSTYLIDÆ Osborn, 1910

The peculiar pelagic *Desmostylus* has been found at quite a number of localities in formations of Miocene age This genus in its restricted sense makes its first appearance on the Pacific Coast in the lower Miocene Vaqueros formation of southern California, and is known to have survived until nearly the close of the upper Miocene, for teeth of *Desmostylus* have been found in the San Pablo group of California Species with similarly constructed teeth have been found in Japan at a number of localities of middle Miocene age, but the Japanese teeth, in so far as one can judge from casts, are smaller than the teeth that have been found in Oregon, in the Montesano formation of Washington, and in the Temblor and San Pablo formations of California Teeth found in the Sooke formation of Vancouver Island, British Columbia, possess the unmistakable peculiarities of the *Desmostylus* group, and have been referred to the genus *Cornwallius* by Dr. O P.

Hay Teeth of this type have not certainly been identified except in formations of unquestionable Miocene age.

The relation of this interesting pelagic mammal to other groups of mammals has occasioned considerable comment in technical journals and elsewhere. The structure of the skull of *Desmostylus* has been interpreted by Marsh, Merriam, Hay, and Matsumoto as demonstrating some degree of affinity to the Sirenia Osborn, Yoshiwara and Iwasaki, and Matsumoto have discussed the supposed resemblances to the Proboscidea More recently, Abel has come to the conclusion that *Desmostylus* is not a placental mammal, but a multituberculate (Allotheria) The basis for this surprising conclusion rests largely on the supposed relations between the jugal bone and the zygomatic arch. The jugal, according to Abel's belief, is excluded from the lower border of the zygoma by the backward prolongation of the maxillary to the glenoid fossa Doctor Hay has described in detail the actual relations of these bones, and he reached conclusions which are opposed to those set forth by Professor Abel.

Our present knowledge of the cranial characteristics of this peculiar mammal is limited to a fairly well preserved skull of a supposedly immature individual of *Desmostylus cymatias*, found in Oregon, which measures 310 mm in length, and the skull of a somewhat larger individual of *Desmostylus japonicus*, found in the province of Teshio, Japan, and measuring 550 mm. in length. The Oregon skull lacks the extremity of the rostrum and the Japanese skull lacks most of the braincase It has been estimated by Matsumoto that the Oregon skull when complete would measure about 380 mm in length and the Japanese skull about 900 mm

Differences in the size and proportions of the cheek teeth as well as in the number of pillars have led to the description of four species of *Desmostylus* The characters that distinguish these species are susceptible of more than one interpretation Greatly worn teeth differ markedly from unworn teeth and the present uncertainty in regard to the validity of the several species is likely to exist until the complete dentition of the upper and lower jaws of one or more of the North American forms is described and figured For the present, the writer is not inclined to be too positive in regard to the allocation of

some of the teeth that have been found and described. Pertinent citations together with lists of localities for the four species that have been described are herewith given.

Genus **Cornwallius** Hay, 1923

1 **Cornwallius sookensis** (Cornwall)

Desmostylus sookensis CORNWALL, Canadian Field Naturalist, vol 36, 1922, p 121, text figs. 1-4—CLARK & ARNOLD, Univ Calif Publ Bull. Dept. Geol Sci, vol 14, no 5, 1923, pp 177-178, pl 39

Cornwallius [*sookensis*] HAY, Pan-Amer Geol., vol 39, March, 1923, p. 107, text fig 4

Cornwallius sookensis HAY, Proc U S Nat Mus, vol 65, publ 2521, 1924, pp 1-8, pls 1-2, text fig 1

Type locality Sooke formation, cliffs between Muir and Kirby creeks, Vancouver Island, British Columbia

Genus **Desmostylus** Marsh, 1888

2. **Desmostylus cymatias** Hannibal

Desmostylus hesperus HAY, Proc U S Nat Mus, vol 49, publ 2113, 1915, pp. 381-397, pls 56-58—ABEL, Acta Zool, häft 2-3, arg 3, 1922, pp 361-394, pls 1-3, text figs 5—ABEL, Sitzungsber kais Akad Wiss, Wien, 1922, pp 1-3—HAY, Pan-Amer Geol, vol 39, 1923, pp 105-109—HAY, Proc. U S Nat Mus, vol 65, publ. 2521, 1924, pp 2-8, text fig 2, pl 1, fig 3—ABEL, Verhandl Zool-Bot Gesell, Wien, bd. 74/75, 1926, pp 134-138—ABEL, *in* M Weber, Die Säugetiere, bd 2, Syst Teil, 1928, p 44, text figs 13-14

Desmostylus cymatias HANNIBAL, Journ Mammalogy, vol 3, no 4, 1922, p 239, pl 11, figs 1-2.

Type locality Temblor formation (according to H G. Schenck), at mouth of Spencer Creek, Lincoln County, Oregon. [No 8181, Division of Vertebrate Paleontology, United States National Museum]

3 **Desmostylus californicus** Hay

Desmostylus hesperus HANNIBAL, Journ Mammalogy, vol 3, no 4, 1922, pp 238-239, pl 12, figs. 8-9

Desmostylus californicus HAY, Pan-Amer. Geol, vol 39, 1923, p 106.

Type locality. San Pablo formation, Monument Peak near San Jose, Santa Clara County, California

Reported from (1) A number of teeth, bones, and fragments of tusks found in shell limestone intercalated with the lower or buff sandstone member of the San Pablo formation on the San Jose Quadrangle, between Monument Peak and the saddle where the road to Calaveras Valley crosses the first ridge of the Diablo range, (2) at a horizon only a few hundred feet higher, a tooth was found in shell limestone about a half a mile south of the saddle where the road to Mount Hamilton crosses the first ridge, and (3) a fragment of a *Desmostylus* tooth, also found in a mixture of limestone and rhyolite tuff interbedded with Monterey shale, on the New Almaden Quadrangle northeast of the Guadalupe quicksilver mines, and associated with *Pecten andersoni* Arnold

4 **Desmostylus hesperus** Marsh

Desmostylus hesperus Marsh, Amer. Journ. Sci and Arts, vol 135, 1888, pp 94-96, text figs 1-3—Merriam, Science, n s, vol 24, 1906, p 151—Merriam, Univ Calif Publ Bull Dept Geol., vol 6, no 18, 1911, pp 403-412, text figs 1-3—Merriam, Trans Amer Philos Soc, n s., vol 22, 1915, pp 13-14, text figs 21a, 21b

Type locality Monterey series (*fide* Hay, 1923, p. 106), Contra Costa County, California (*fide*, Merriam, 1911, p 404).

Reported from Monterey formation north of Coalinga, N W ¼ of Sec 29, T 18 S, R 15 E, Big Blue Hills, Fresno County, Coalinga Quadrangle, U S G S; Vaqueros [Temblor] formation in Canoas Cañon, Fresno County, Sec. 33, T 22 S, R 16 E, Cholame Quadrangle, U S G S, Temblor horizon in region of Devil's Den on west side of San Joaquin Valley, Kern County, T 25 S, R 18 E, Cholame Quadrangle, U S G S; Temblor horizon on east side of San Joaquin Valley in Kern River region, shales and sandstones of supposedly Vaqueros formation in San Luis Obispo County, shale and sandstone, supposedly Vaqueros, about 6 miles northeast of Santa Ana, Orange County, Corona Quadrangle, U S G S.

5. **Desmostylus japonicus** Tokunaga & Iwasaki

Desmostylus japonicus YOSHIWARA & IWASAKI [New Fossil Mammal], Journ. Coll Sci. Imp Univ Tôkyo, vol 16, art. 6, 1902, pp 1-13, pls 1-3, text figs. 4.

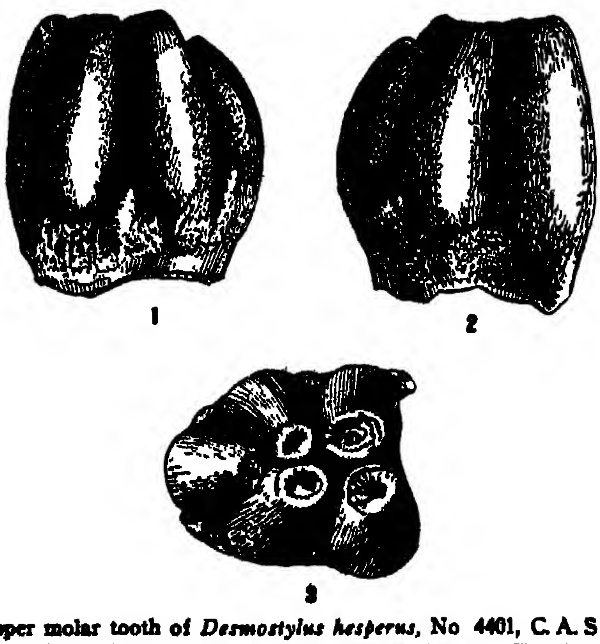
Desmostylus sp MERRIAM, Univ Calif Publ Bull Dept. Geol, vol 6, no 18, 1911, pp 406-412, text figs 4-11

Desmostylus japonicus TOKUNAGA & IWASAKI, Journ Geol Soc. Tokyo, vol. 21, 1914, p. 33.—MATSUMOTO, Sci. Reports Tohôku Imp. Univ., ser 2, 1918, Geol., vol. 3, no 2, pp. 61-74, pl 22, figs 1-3.

Desmostylus watasei HAY, Proc U S Nat. Mus., vol 49, publ 2213, 1915, p 396

Type locality. Tufaceous sandstone, at Togari in Kanigori, Province of Mino, Japan

Reported from Togari [= type locality], Yamanouchi, and Tsukiyoshi, Toki District, Province of Mino; Yumachi, Province of Izumo, Yuda and Shikonai, Ninohe District, Province of Mutsu, a tributary of the Opiraushibets, Province



1 2 3

Left upper molar tooth of *Desmostylus hesperus*, No 4401, C. A. S., × 0.5 Fig 1 Internal view Fig 2 External view Fig. 3 Occlusal view

of Teshio, Hokkaido; and Toshibets, Province of Shiribeshi, Hokkaido [Matsumoto, 1918, p 73].

The Temblor tooth (No 4401, C A S.), hereinafter described, is fully as large as one with nine pillars recently found by Ray E Matthews in a railroad cut near Vesta, Grays Harbor County, Washington This last mentioned tooth and other bones in the possession of Mr Matthews, were described in a letter written by Rev. J Herbert Geoghegan to Dr O P Hay, as having been found in what appeared to be concretions of gray sandstone or well cemented mud in a stratum composed of red sandstone and gravel This deposit was considered to be a part of the upper Miocene Montesano formation. The length of this tooth is given as 3½ inches and the height as 3 inches The greatest length of the incomplete Temblor tooth is 72 mm , maximum width, 59 5 mm , height of tooth at level of posterior pillar, 68.5 mm , and greatest height at level of anterior pair of pillars, 81 3 mm. It is thus apparent that teeth of large size and similar configuration are found in formations varying in age from lower to upper Miocene The proportions of the adult teeth of the Oregon *Desmostylus cymatias* are unknown, and, for the present, it seems advisable to refer the Temblor tooth tentatively to *Desmostylus hesperus*

That this tooth (fig 3) originally consisted of more than five high columns or pillars is shown by the broken border at one end of the base When the tooth was complete there were at least three pairs of pillars in addition to the single posterior pillar, and one or more at the anterior end. The root is missing, and the exposed smooth surface of the dentine at the base of the crown, as viewed from below, exhibits a general resemblance to that of a mastodon. Beneath the core of each pillar is a deep conical pulp cavity, and these cavities are separated by a median longitudinal ridge. The end pillar (fig 2) is somewhat shorter than the others and is closely appressed to the succeeding pair, but all five of these columns are nearly circular in cross section. The paired pillars curve upward and inward to the median longitudinal axis and have their apices in contact with their opposites.

Each of these pillars is covered with a rather thick outer enamel layer which is with difficulty distinguished from the

thicker concentric layers of dentine This tooth is relatively unworn, and hence the crowns of the pillars have a thick enamel rim inclosing a small central pit whose floor is the tip of the central dentine core. The outer surface of the enamel layer is quite rugose This tooth does not have a distinct cingulum at the base of the crown, but, nevertheless, a small irregular nodosity covered with rugose enamel projects upward from the base between each of the pillars With wear, the circumference of the central pulp cavity increases until in a badly worn tooth the diameter may be thrice the combined thickness of the outer enamel and dentine rings

Order PINNIPEDIA

Family ALLODESMIDÆ Kellogg, new family

Extinct Eared Seals

6 **Allodesmus kernensis** Kellogg[3]

Skeletal elements of several individuals, and representing old and young, and possibly both sexes, of this fossil Temblor otariid, are included in the collections made by Charles Morrice The major portion of the material which has been put at the writer's disposal belongs to the California Academy of Sciences, but additional specimens were found in a small collection presented several years ago to the United States National Museum by Mr Morrice This material adds considerably to our knowledge of the morphological history of the Otariidæ and especially of the limb structure

After carefully considering all the evidence, the writer is unwilling to propose one or more new names based on doubtfully distinct bones, yet this disposition of the material is not, however, made without grave misgivings that the reasons for allocating some of the skeletal elements to this fossil pinniped are unsound There are obvious differences in some of the carpal and tarsal elements, particularly in the scapho-lunar, calcaneum, and cuboid bones In reviewing the skeletal elements it will be observed that the fore and hind limbs do not differ materially from those of living otariids, either in the

[3] R. Kellogg, Pinnipeds from Miocene and Pleistocene deposits of California. Univ Calif Publ, Bull. Dept. Geol. Sci., vol. 13, no 4, 1922, pp. 26-44

proportions of their component parts or in their articular relations There are minor differences in the vertebral column, but the sternum and pelvis exhibit the typical otariid characteristics The mandible is not materially unlike that of the living otariids, but the skull possesses some anomalous features, of which the backward and outward extension of the premolar-molar series toward the anterior end of the zygoma is probably the most striking The present material tends to confirm the geological antiquity of the otariid stock, but the source and time of its divergence from terrestrial relatives remain unsettled The various skeletal elements, which are referred to this pinniped, are herewith listed

Large Individuals— (?) Old Males

Left scapula (No 11857, U S N M), incomplete
Left humerus (No 11858, U S N M), distal end only
Left radius (No 4292, C A S.), distal end missing
Right ulna (No 4336, C A S), distal epiphysis only
Left ulna (No 4335, C. A. S), distal epiphysis missing
Right scapho-lunar (No 11859, U S N M), eroded
Right scapho-lunar (No 4332, C A S), eroded
Left magnum (No 11860, U S N M), complete
Left metacarpal I (No 4466, C A S), proximal end only
Left metacarpal II (No. 4478, C A S), eroded
Right metacarpal II (No 4481, C A S), proximal end only
Left metacarpal V (No 4480, C A S), proximal end only
Phalanx (No 4476, C A S), proximal end slightly eroded
Phalanx (No 4477, C A S), proximal end slightly eroded
Phalanx (No 4479, C A S), proximal end slightly eroded
Right femur (No 4294, C A S), complete
Left femur (No 4295, C A S), internal condyle damaged
Right tibia (No 4302, C A S), both epiphyses missing
Left tibia (No 4303, C A S), distal epiphysis missing
Left tibia (No 4494, C A. S), distal epiphysis only
Left fibula (No 4305, C A. S), complete
Left patella (No 4328, C A S), complete
Right patella (No. 4329, C A S), complete
Left patella (No 11655, U S N M), complete.
Left patella (No. 4326, C. A. S), complete.
Left calcaneum (No 4309, C. A. S), complete.
Right calcaneum (No 4310, C A S), tuberosity damaged
Left astragalus (No 4308, C A S), complete
Left navicular (No 4321, C A. S), complete
Left cuboid (No 4319, C. A. S), complete

Right cuboid (No. 4318, C. A. S.), postero-internal angle of distal face missing
Left entocuneiform (No 4323, C. A. S.), complete
Right entocuneiform (No 4324, C. A. S.), complete.
Left entocuneiform (No 4322, C. A. S.), complete
Right metatarsal V (No 11861, U. S. N. M.), proximal end only
Right innominate bone (No 4360, C. A. S.), distal half missing
Atlas (No 4398, C. A. S.), nearly complete.
Atlas (No 4414, C. A. S.), incomplete.
Fifth cervical (No 4407, C. A. S.), incomplete
Sixth cervical (No 4399, C. A. S.), nearly complete
Sixth cervical (No 4408, C. A. S.), incomplete
First dorsal (No 4412, C. A. S.), incomplete
Fourth (?) dorsal (No. 4417, C. A. S.), incomplete.
Fifth (?) dorsal (No 4416, C. A. S.), incomplete
Posterior dorsal (No 4421, C. A. S.), incomplete.
Sternal segments (Nos 4403, 4405, 4430, 4404, 4429, 4402, 4428, C. A. S.)
Left mandible (No 4395, C. A. S.), posterior end missing
Right mandible (No 4426, C. A. S.), incomplete
Left mandible (No 4486, C. A. S.), both ends missing
Left maxillary fragment with canine (No 4396, C. A. S.).
Right maxillary fragment with canine (No 4397, C. A. S.).
Many teeth (Nos 4580 to 4596, C. A. S.)

INDIVIDUALS OF MEDIUM SIZE—FEMALES OR YOUNG MALES

Right humerus (No 4337, C. A. S.), proximal epiphysis and distal end missing
Right humerus (No. 4338, C. A. S.), distal end only
Left radius (No 4293, C. A. S.), proximal end only
Right radius (No 4291, C. A. S.), proximal end only
Right radius (No 11863, U. S. N. M.), proximal end only
Right radius (No 4292, C. A. S.), fairly complete
Right radius (No 11866, U. S. N. M.), distal end only
Right scapho-lunar (No 4369, C. A. S.), angle eroded
Right scapho-lunar (No 4334, C. A. S.), eroded
Right unciform (No 11862, U. S. N. M.), slightly eroded
Left trapezium (No 4331, C. A. S.), complete
Left metacarpal I (No 4465, C. A. S.), proximal end only
Left metacarpal I (No 11864, U. S. N. M.), proximal end only
Right metacarpal III (No 4463, C. A. S.), complete
Left metacarpal III (No 4462, C. A. S.), proximal end only.
Left metacarpal III (No 4459, C. A. S.), complete.
Left metacarpal III (No 4460, C. A. S.), complete
Left metacarpal III (No. 4461, C. A. S.), complete
Right metacarpal IV (No. 4458, C. A. S.), distal end damaged.
Right metacarpal V (No 4451, C. A. S.), slightly eroded
Right metacarpal V (No 4467, C. A. S.), slightly eroded.

Phalanx (No 4468, C A S.), distal end missing.
Phalanx (No 4469, C A. S.), complete
Phalanx (No 4470, C A S), slightly eroded
Phalanx (No 4471, C A S), distal end missing
Phalanx (No 4472, C A S), complete
Phalanx (No 4473, C A S), complete
Phalanx (No 4474, C A S), complete
Phalanx (No 4475, C A S), complete
Phalanx (No 4482, C A S), complete
Right femur (No 4299, C A S), proximal end only.
Left femur (No 4301, C A S), distal end only
Right femur (No 4298, C A S), distal end only
Right femur (No 4491, C A S), distal end only
Right femur (No 4296, C A S), both epiphyses missing
Left femur (No 4297, C A. S.), both epiphyses missing
Left tibia (No 4304, C A S), complete
Right tibia (No 4492, C A. S), proximal end only
Right tibia (No. 4493, C A S), proximal epiphysis only
Right patella (No 11545, U S N M)
Left patella (No 4327, C A S).
Right patella (No 4330, C A S)
Right patella (No 4325, C A. S)
Right calcaneum (No 11540, U S N M), complete.
Right calcaneum (No 11589, U S N M), complete
Right calcaneum (No 4312, C A S), eroded
Right calcaneum (No 4314, C A S), eroded
Left calcaneum (No 4313, C A S), distal extremity damaged
Left calcaneum (No 4315, C A S), eroded
Right astragalus (No 4306, C A S), complete
Left astragalus (No 4307, C A S), tibial face damaged
Left astragalus (No 11541, U S N M), complete
Left astragalus (No 4311, C A S), damaged
Left navicular (No 11551, U S N M), complete.
Left navicular (No 11550, U S N M), complete
Right entocuneiform (No 11546, U S N M), complete
Left cuboid (No 4317, C A S), eroded
Right cuboid (No 4316, C A. S), complete
Right cuboid (No 4320, C A S), eroded
Left metatarsal II (No 4452, C A S), proximal end only
Left metatarsal II (No 4454, C A S.), proximal end damaged
Left metatarsal II (No 4453, C A. S), eroded
Right metatarsal II (No, 4456, C A S), incomplete proximal end only
Right metatarsal II (No 4457, C A S), incomplete proximal end only
Right metatarsal II (No. 4455, C A S), eroded
Left metatarsal III (No. 4450, C A S), distal end missing
Right metatarsal IV (No 4448, C A S), complete
Left metatarsal IV (No 4449, C A S), distal end missing
Right metatarsal V (No 11870, U S N M), proximal end only

Right metatarsal V (No. 4446, C. A. S.), eroded.
Right metatarsal V (No. 4447, C. A. S.), eroded.
Atlas (No. 4484, C. A. S.), right and left halves.
Third cervical (No. 4409, C. A. S.), incomplete.
Fourth cervical (No. 4410, C. A. S.), incomplete.
Fifth cervical (No. 4411, C. A. S.), incomplete.
First dorsal (No. 4418, C. A. S.), incomplete.
Second dorsal (No. 4419, C. A. S.), incomplete.
Anterior caudal (No. 4557, C. A. S.), incomplete.
Anterior caudal (No. 4558, C. A. S.), incomplete.
Anterior caudal (No. 4556, C. A. S.), incomplete.
Median caudal (No. 4554, C. A. S.), incomplete.
Median caudal (No. 4552, C. A. S.), incomplete.
Posterior caudal (No. 4550, C. A. S.), incomplete.
Posterior caudal (No. 4551, C. A. S.), incomplete.
Posterior caudal (No. 4553, C. A. S.), incomplete.
Sternal segments (Nos. 4431, 4433, 4434, C. A. S.).
Right mandible (No. 4487, C. A. S.), posterior end missing.
Left mandible (No. 4488, C. A. S.), posterior end missing.
Right mandible (No. 4489, C. A. S.), anterior extremity only.
Left mandible (No. 4490, C. A. S.), anterior extremity only.
Extremity of left premaxilla with canine (No. 4427, C. A. S.).

Aside from its much larger size and the tooth modifications, the general aspect of the skull of *Allodesmus kernensis* may have resembled somewhat those of the White River Oligocene cats, *Hoplophoneus primævus* and *Dinictis felinus*, with a shortened face, short and heavy rostrum, massive mandibles, backward prolongation of superior portion of the supraoccipital, and expanded zygomatic arches. The backward prolongation of the median apical portion of the supraoccipital considerably beyond the level of the condyles, and the presence of a strong vertical median ridge, which acts as a brace for the lambdoid crest, are quite unlike the retreating curvature of the vertex of the supraoccipital in living otariids. Both *Dinictis* and *Hoplophoneus* have mandibles with a pronounced genial tuberosity, but this tuberosity is much reduced in *Allodesmus*. It is possible that *Allodesmus* may have been derived from a progenitor whose mandible had a somewhat larger genial tuberosity, but it is equally probable that the development of a genial tuberosity in *Dinictis* and *Hoplophoneus* accompanied the elongation of the canines, and that it bears some relation to the functional use of these teeth. Furthermore, in case of *Dinictis* and *Hoplophoneus*, not more than

two or three of the upper and lower premolars are present, but one upper molar remains, and the lower molars are reduced to one or two. In both of these felids, the fourth upper premolar is the carnassial, while in *Allodesmus* the upper cheek teeth appear to progressively diminish in size from the anterior to the posterior end of the series. In the mandible, the fourth premolar is the largest cheek tooth. The carnassial teeth are not differentiated in either the upper or the lower premolar-molar series. Furthermore the large canines are equally developed in the upper and lower jaws of *Allodesmus*. As with *Allodesmus*, these Oligocene cats have a consolidated scapholunar-centrale.

Patriofelis[4] from the middle Eocene of the Bridger Basin, Wyoming, has an outwardly curved premolar-molar series, so it would appear that *Allodesmus* retains some of the creodont heritage, especially in the curvature of the upper cheek teeth, the persistence of two small upper molars, and the location of the antorbital foramen at the level of Pm^4. But *Patriofelis* with its large, massive skull, shortened face, broadly and abruptly truncated rostrum, and shearing M^1 and M_2 does not seem to possess any close phylogenetic relationship with *Allodesmus*. The enlarged and powerful second lower molar, according to the general rules of probability, would not be expected to disappear in dental reduction. Furthermore, the scaphoid, lunar, and centrale are separate bones in the carpus of *Patriofelis*. The pelvis also presents a number of anatomical characters not found in *Allodesmus*.

Some of the Miacidæ[5] have an outward bowed upper molar-premolar series, especially *Miacis* and *Vassacyon*. Matthew[6] has shown that the scaphoid, lunar, and centrale are consolidated in *Vulpavus profectus*, and it is possible that the fusion of these elements may have taken place in other members of this family of creodonts. There is no available evidence to show that the consolidation of the scaphoid, lunar, and centrale has taken place since entering an aquatic environment, and, in

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[4] J. L. Wortman, Bull. Amer. Mus. Nat. Hist., vol. 6, art. 5, 1894, pp. 129-164, pl. 1, figs. 1-5.—W. D. Matthew, Mem. Amer. Mus. Nat. Hist., vol. 9, pt. 6, 1909, pp. 420-432, figs. 50-52.

[5] W. D. Matthew & W. Granger. A revision of the Lower Eocene Wasatch and Wind River Faunas. Bull. Amer. Mus. Nat. Hist., vol. 34, art. 1, 1915, pp. 33-34, 41-42.

[6] W. D. Matthew, Mem. Amer. Mus. Nat. Hist., vol. 9, pt. 6, 1909, p. 388, fig. 29.

the absence of such confirmatory evidence, it would seem that the otariids were descended from terrestrial creodonts in which these carpal elements were consolidated

Inasmuch as the carefully considered evidence assembled by Matthew[7] and Gidley[8] seemed to indicate that the clænodonts were progressing toward the Ursidæ in the distinctive characters of the teeth and feet, it was necessary to examine their possible relationships to the Otariidæ In a more recent communication,[9] however, Doctor Matthew questions the supposed relationship between the Arctocyonidæ and the Ursidæ In the carpus of *Clænodon* and *Neoclænodon* the scaphoid and centrale are fused, and, although the lunar-centrale facet persists, the lunar-scaphoid facet has disappeared and is replaced by a roughened bony surface These details seem to point to the imminent union of the scaphoid and lunar.

The tarsal bones exhibit a number of distinctive features not found in any of the Otariidæ The astragalus of *Allodesmus kernensis* differs from that of *Neoclænodon montanus* (No 9779, U S N M) in having (1) the trochlea continued farther proximally in a plantar direction, (2) the astragalar foramen open or closed, (3) a narrow oblique groove for the flexor digitorum on the tibial border of plantar prolongation of the body, in contrast to the unusually broad groove which occupies most of the plantar prolongation of the body in *Neoclænodon*, and (4) the head less flattened and narrower from side to side

Although the calcaneum of *Allodesmus* is quite similar in general shape to that of *Neoclænodon* (No 8362, U S N M) it differs in having (1) a shorter stouter shaft, (2) a less proximally extended sustentacular facet, (3) a narrower distal facet for the cuboid, (4) a shallower interosseous groove between ectal and sustentacular facets, and (5) a less protuberant peroneal tubercle

The cuboid of *Allodesmus* differs from that of *Neoclænodon* (No 8362, U S N M) in having (1) a relatively smaller

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[7] W D Matthew, Additional observations on the Creodonta Bull. Amer Mus. Nat. Hist, vol 14, art 1, 1901, pp 14-15

[8] J. W Gidley, New species of Clænodonts from the Fort Union (Basal Eocene) of Montana. Bull Amer Mus. Nat. Hist, vol 41, art 14, 1919, pp 541 55, text fig 10, pl. 28

[9] W D Matthew, The evolution of the mammals in the Eocene Proc Zool. Soc. London, 1928, p 971

and more convex facet for calcaneum; (2) a more oblique curvature of astragalar facet and a more reduced navicular facet, (3) a reduced proximal facet for ectocuneiform; and (4) the presence of facets on distal end for metatarsals IV and V, whereas there is but a single facet on the cuboid of *Neoclænodon*

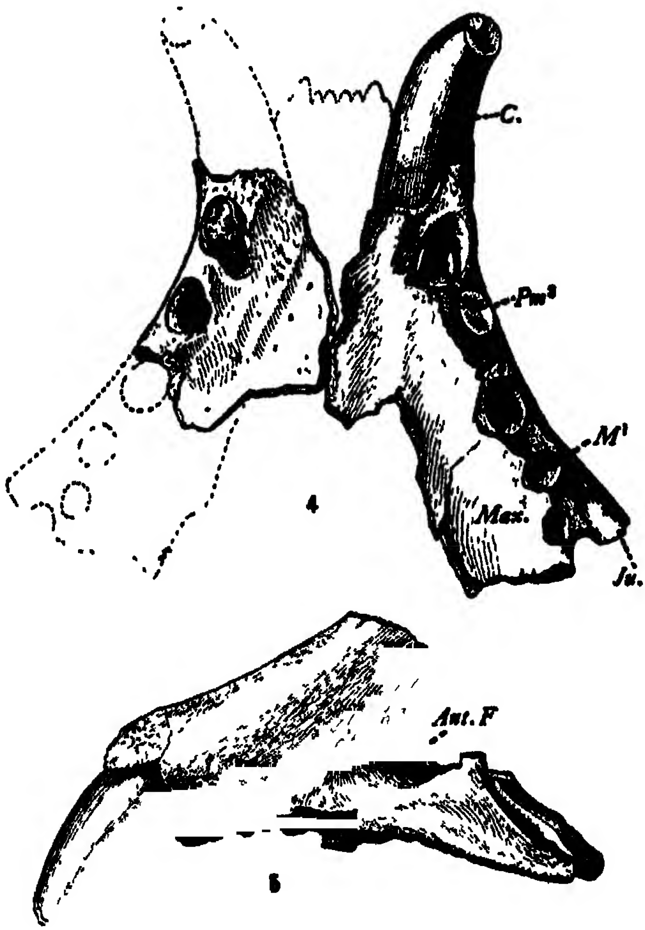
Matthew has called attention to (1) the slender, serrate, and unworn canines; (2) the reduction of the premolars; and (3) the presence of low-cusped quadrate molars, with lower M_3 somewhat reduced. The derivation of the Otariidæ from the clænodonts is beset with several obstacles, inasmuch as the clænodonts are characterized by, (1) the presence of a protuberant, outwardly curved, lesser trochanter below the head of the femur, (2) the presence of a distinct third trochanter at a lower level on the external border of the shaft, (3) the presence of an entepicondylar foramen in the humerus, (4) the fact that the upper M^2 and the lower M_3 are the largest of the cheek teeth and hence would not be expected to be reduced in the course of dental reduction, and (5) the presence of keeled, fissured, ungual phalanges, with no trace of a basal sheath

In view of the debatable nature of the evidence which has been brought forth to support the theory of the derivation of the otariids from members of several families of creodonts, it would appear that they can not be derived from any known genus, and, in so far as some osteological characters are concerned, the Otariidæ may retain as much of the felid heritage as they do of the ursid heritage The dentition of the Otariidæ is quite unlike either of the last mentioned groups

The foregoing remarks are intended to supplement the summary[10] published in 1922 Nevertheless it would appear that in the progressive evolution of the otariids, (1) the facial region was deepened, (2) the spreading or outbowing of the zygomatic arches was reduced; (3) the antorbital foramen was moved backward, (4) one lower incisor was lost, (5) the first upper premolar was lost, (6) the upper and lower molars were reduced in size, (7) the premolar-molar series were moved inward with the side to side compression of the rostrum and the opposite rows became nearly parallel, (8) the notch

[10] R Kellogg, Univ Calif Publ, Bull. Dept Geol Sci., vol 13, no. 4, 1922, pp 94 97

between the palatal portion of the maxillary and the jugal was widened, and (9) the posterior narial gutter was closed in by the narrowing and backward prolongation of the palatal region.



Rostral fragments of the skull of *Allodesmus kernensis*, × 0.5 Fig 4 Palatal view of right and left rostral fragments, Nos. 4397 and 4396, C. A. S Fig 5 Lateral view of left rostral fragment, No 4396, C. A. S.

SKULL

Portions of the rostrum of at least two and possibly three individuals are represented in this collection Of these, a portion of the left maxillary (No 4396, C A S), with large canine, roots of Pm^2 and Pm^3, as well as the alveoli for Pm^4, M^1 and M^2, is the most nearly complete A portion of the right maxillary (No 4397, C A. S) with alveolus for canine, the root of Pm^2, and the alveolus of Pm^3 seems to belong with specimen No 4396, C A. S , but there is no certainty that this association is correct, since the two portions of the rostrum were in separate packages when received. There is in addition to the above, a fragment of another right maxillary (No 4426, C A S) bearing a large canine tooth and alveoli for a small Pm^1, a rather large Pm^2, and smaller Pm^3 and Pm^4 The occipital region of the skull[11] of this fossil pinniped was described in 1922.

By referring to text fig 4, it will be seen that the rostrum of this pinniped differs from all living otariids in having an outwardly curved premolar-molar series, with Pm^4, M^1, and M^2 actually outside of the level of the antorbital foramen, whereas in the living *Eumetopias, Zalophus,* and *Arctocephalus,* the two series are nearly parallel and lie within the level of the antorbital foramina That portion of the maxillary which forms the roof for the antorbital foramen is missing, but the anterior orifice of the latter lies at the level of Pm^4 Although the peculiar outward curvature of the premolar-molar series is quite unlike any living pinniped, it is obvious that the cheek teeth were not carried backward upon the anterior end of the zygomatic arch, for the small second upper molar is placed within, and anterior to, the narrow notch between the antero-inferior process of the jugal and the palatal portions of the maxillary. The number of upper incisors is unknown The canine is a large recurved tooth, with crown covered with a thin coat of enamel The alveolus of a small Pm^1 is present on one specimen (No 4427, C. A. S), but no trace of it can be found on the larger rostral fragment (No 4396, C A S) It is barely possible that this tooth may belong with the milk dentition, since it lies slightly internal to

[11] R Kellogg, Univ Calif Publ., Bull Dept. Geol Sci., vol. 13, no 4, 1922, pp 29 32, text figs 2a 2b.

the much larger succeeding premolar Assuming that this represents the alveolus of the first upper premolar, then the second upper premolar has the largest root of the premolar series and may have had a larger crown than the others The alveoli of the cheek teeth progressively decrease in size from the anterior to the posterior end of the series The roots of all the cheek teeth were implanted obliquely, and, with the exception of the molars, all were implanted on the outer edge of the maxillary The almost horizontal direction of the alveolus for the small second upper molar seems to offer an explanation for the loss of this tooth by the living genus *Eumetopias* The direction of this alveolus indicates that the tooth could hardly function in any normal manner, and hence would tend to be reduced in the course of time The upper cheek teeth appear to consist of four premolars of which Pm^1 is usually missing, and at least two small molars It is impossible to determine from the material at hand whether or not this form has a third upper molar

Viewed from the side (fig 5), the depth of the maxillary (54 mm, No 4396, C A S) at the level of the antorbital foramen is about one-half of that (98 mm, No 7140, U S N M) of an old adult *Eumetopias jubata* The sinuous curvature of the superior margin of the maxillary of *Eumetopias* also is quite unlike the sloping margin of the maxillary of this fossil pinniped The premaxillary and the incisors are missing The external narial orifice is narrower and the infraorbital portion of the maxillary is prolonged farther backward than in any living otariid

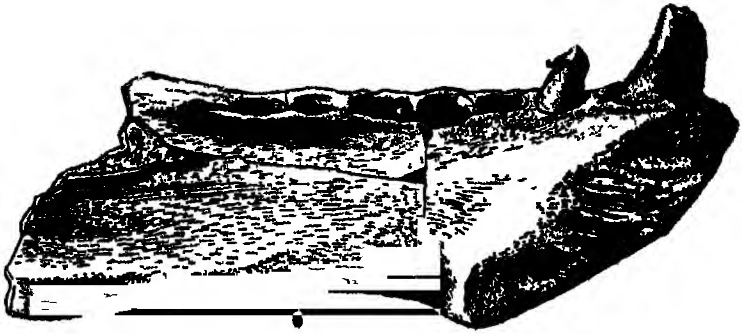
The skull of *Allodesmus* differs from that of *Eumetopias* in having (1) the premolar-molar series curving outward and ending near level of anterior end of zygomatic arch, (2) at least five functional upper cheek teeth which decrease in size from anterior to posterior end of the series, (3) a rather large second upper premolar, (4) no indication of a basirostral constriction, (5) an obvious backward prolongation of infraorbital portion of maxillary, (6) antero-inferior process of jugal extending forward to level of first upper molar, (7) a wider palate, and (8) a conspicuous lambdoid crest, with median apical portion prolonged backward

Among the fragmentary and more or less complete teeth referred to *Allodesmus kernensis* are two molars, nine premolars, and three canines The molars have small crowns and unusually short roots All of the premolars have rather long roots, and many of them have a pronounced longitudinal external groove The crowns of all these cheek teeth have the appearance of being covered with fairly smooth enamel, although on closer inspection it will be seen that it is finely pitted With the exception of the larger premolars, all of the cheek teeth have rather low crowns, with the apical portion curving inward The base of the crown is swollen and its circumference is greater than that of the root Two of the larger premolars exhibit rudiments of basal nodosities at the postero-internal angle The roots of the cheek teeth are often asymmetrical and taper irregularly, but the pulp cavity is closed The large canines, with recurved crowns which often pass imperceptibly into the neck, have an open pulp cavity Three teeth, with strongly recurved apices and pronounced basal rugosities on the internal face, agree sufficiently with the incisors of *Eumetopias* to be considered such. The crown is but slightly swollen at the base, and the root has a distinct neck, below which is a pronounced enlargement. The pulp cavity in the roots of these teeth is closed and the roots are asymmetrical.

Mandible

Portions of seven mandibles belonging to individuals of different sizes agree with the type mandible of *Allodesmus kernensis*[12] in all their essential details Three of these belong to large individuals and they are, respectively, a nearly complete left mandible (No 4395, C A S); an incomplete right mandible (No. 4426, C A S), and a section of a left mandibular ramus (No. 4486, C A S), having both ends missing Four belong to considerably smaller individuals, possibly females or young males, and are apparently the anterior halves of the right (No. 4487, C A. S) and the left (No 4488, C A S.) mandibles of one individual, the anterior extremity of a right

[12] R Kellogg, Univ Calif Publ. Bull Dept. Geol. Sci., vol. 13, no 4, 1922, pp 26 28, figs. 1a, 1b.



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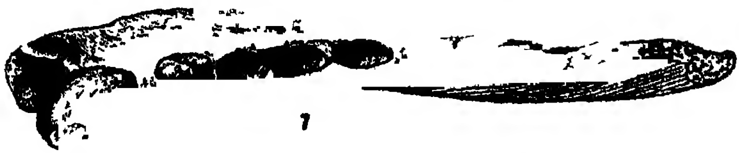

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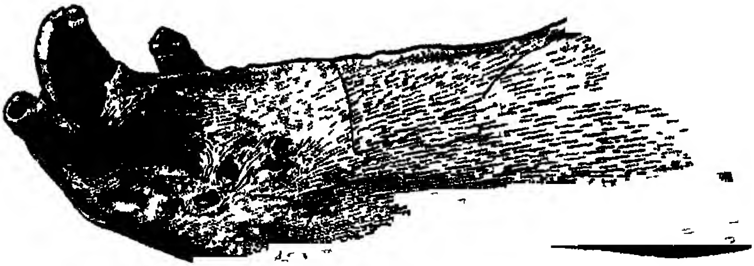

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Incomplete left mandible of *Allodesmus kernensis*, No 4395, C A S, × 0 5 Fig 6 Internal view Fig 7 Dorsal view Fig 8 External view

mandible (No. 4489, C A S), and the corresponding portion of another right mandible (No 4490, C A S)

The largest of these mandibles lacks the coronoid process, the condyle, and the angular process This left mandible (fig 8) is approximately the same size as the type right mandible and is much more nearly complete The canine and the first premolar are in place, and there are, in addition, alveoli for two incisors, three premolars, and two molars As compared

with the corresponding mandible of a large adult *Eumetopias jubata* (No 7140, U. S N M) this fossil mandible is characterized by a longer and more oblique symphysis, a somewhat deeper ramus, a more posterior and shallower masseteric fossa, and a more pronounced genial tuberosity The number and position of the mental foramina agree with *Eumetopias,* but the cheek teeth are larger, and the outer incisor is considerably larger.

The external face of the mandibular ramus (fig. 9) is flattened superiorly, but, taken as a whole, the external surface exhibits a convex curvature and the internal a concave curvature The ramus is about as thin as in *Eumetopias* The symphysial surface (fig 6) is deeply pitted and corrugated as in *Eumetopias,* indicating that the opposing mandibles were appressed very closely and bound together by ligaments The alveoli of the cheek teeth (fig 7) are very closely spaced, the length of the lower series measuring 141 mm from the anterior margin of the canine to the posterior border of the alveolus of the second lower molar in the largest mandible (No 4395, C A, S.) The antero-posterior diameter of the crown of the first lower premolar is 11.7 mm (No 4395, C. A S) The corresponding measurement of the third lower premolar is 13 6 mm and that of the first lower molar, 11 5 mm., in another left mandible (No 4486, C A S) of approximately the same size The curvature of the superior border of the last mentioned mandible indicates that the coronoid process slopes more gradually upward than in *Eumetopias* The rounded crowns of the first lower premolar, the third lower premolar, and the first lower molar are covered with fairly smooth enamel The enamel crowns of less worn cheek teeth are often finely pitted

The available evidence indicates that *Allodesmus* is not ancestral to *Dusignathus*[18] and that the living *Eumetopias* may be a derivative of *Allodesmus. Dusignathus* differs from *Allodesmus* in having (1) a shorter and lighter mandibular ramus, (2) cheek teeth with larger roots, without pronounced longitudinal external groove; (3) crowns of cheek teeth with smooth, highly polished enamel in contrast to finely pitted enamel of *Allodesmus* cheek teeth; (4) loss of second lower

[18] R Kellogg, Fossil Pinnipeds from California. Publ. 346, Carnegie Inst, Washington, 1927, pp. 27 33, text figs. 1-6

molar, (5) more oblique slope of anterior margin of coronoid, and (6) strong convexity of lower mandibular border between genial tuberosity and lower angular process

Measurements of Left Mandible (No 4395, C A S)

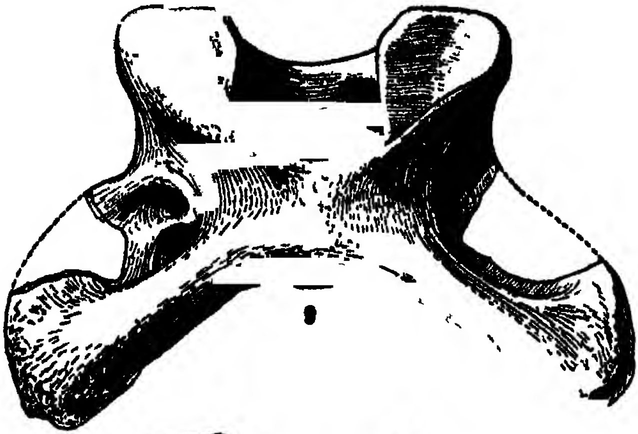
Greatest length of symphysis	. 106 0 mm.
Depth of ramus between fourth premolar and first molar	62 0 mm
Antero-posterior diameter of alveolus, first incisor	12 0 mm
Antero-posterior diameter of alveolus, second incisor .	8 5 mm
Antero-posterior diameter of alveolus, canine ..	32 0 mm
Antero-posterior diameter of alveolus, first premolar	13.2 mm
Antero-posterior diameter of alveolus, second premolar	16.4 mm
Antero-posterior diameter of alveolus, third premolar. ..	17 0 mm
Antero-posterior diameter of alveolus, fourth premolar ...	17.8 mm.
Antero-posterior diameter of alveolus, first molar	12.2 mm
Antero-posterior diameter of alveolus, second molar .	8 0 mm

As compared with the mandible of an old adult *Eumetopias jubata* (No 7140, U S N M) this fossil mandible (No. 4395, C A S) has: (1) a canine with a narrower root, (2) larger and more crowded cheek teeth, (3) considerably longer premolar-molar series; (4) a small second lower molar, (5) a distinct interval between the fourth premolar and the first molar, (6) cheek teeth with no indication of a cingulum or fringe of basal rugosities, (7) a more posteriorly situated inner incisor, and (8) a much larger outer incisor

The mandibles of the smaller individuals agree in all essential details with the larger mandibular rami, but are lighter and have smaller teeth The left mandible (No 4487, C A S) of one of these has a canine with a complete crown, which is recurved and somewhat compressed from side to side, but without any indication of anterior or posterior carinæ The symphysis of this mandible is less pitted and less rugose than in those belonging to larger individuals

VERTEBRÆ

The vertebral column of an old male sea lion (*Eumetopias jubata*) is considerably larger than that of young males and old females, and it would appear from the present material that sexual dimorphism was equally well marked in *Allodesmus.* Seven cervical vertebræ belonging to a very large



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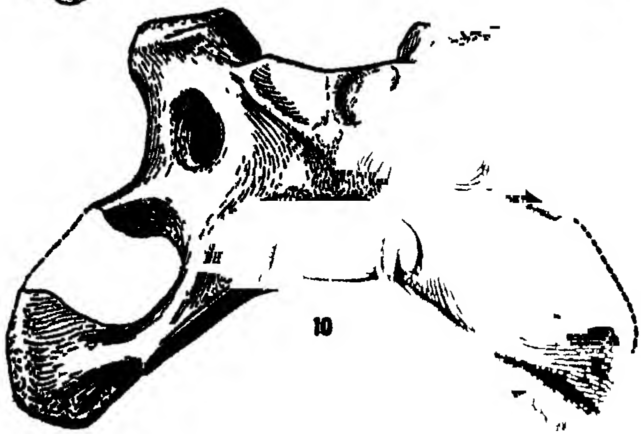

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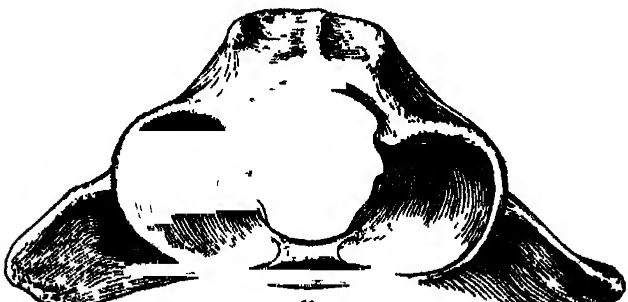
Atlas of *Allodesmus kernensis*, No 4398, C A S, × 0 5 Fig 9 Ventral view Fig 10 Dorsal view

individual are referred to an old male Unfortuntely most of these vertebræ are badly damaged. One nearly complete atlas (No 4398, C A S) and another damaged one (No 4414, C A S) show that this vertebra in *Allodesmus* differs very little from the corresponding bone in *Eumetopias jubata* The antero-posterior diameter of the neural arch (fig 10) is relatively greater, and the transverse processes are less incurved The neural arch is perforated on each side by a large vertebrarterial foramen, and postero-internally on each side is the orifice of the canal that passes through the transverse process and

emerges on its internal face at a point more than half way to the extremity The articular surface for the odontoid, as well as those for the facets on the anterior face of the centrum of axis, corresponds with that of *Eumetopias* Not even a vestige of the neural spine is retained The anterior articular surfaces (fig 11) for the condyles of the skull are deep and strongly concave The curvature of these facets is likewise similar to that in *Eumetopias* As seen from the ventral side (fig 9), this fossil atlas differs from that of *Eumetopias* in having transverse processes with larger fossæ through which the vertebrarterial canals pass

The fifth cervical (No 4407, C A S) is incomplete, with both epiphyses, neural spine, and transverse processes missing The neural arch is lower and less vaulted, but the size, shape, and direction of the pre- and post-zygapophyses agree with those in the corresponding cervical of Eumetopias Further-



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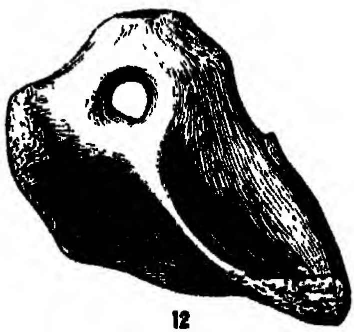

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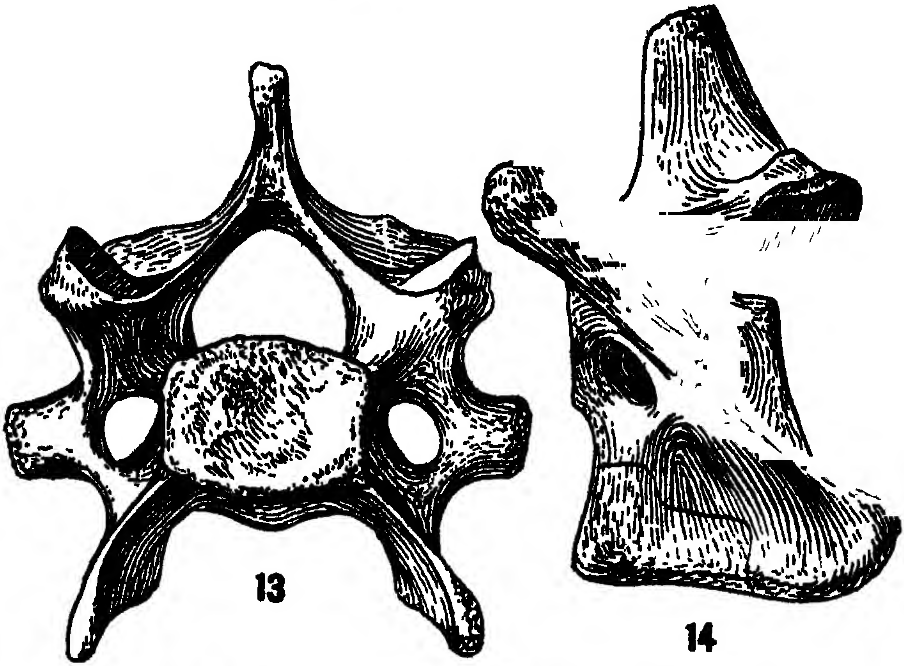
Atlas of *Allodesmus kernensis*, No 4398, C A S, × 0 5 Fig 11 Anterior view Fig 12 Lateral view

more, the lateral vertebrarterial canal is slightly larger, the neural arch is much wider, and the transverse process is about three-fourths as broad at the base



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14

? Sixth cervical vertebra of *Allodesmus kernensis*, restored, No 4399, C A S, × 0.5 Fig 13 Anterior view Fig 14 Lateral view

Two vertebræ, which have the same structural characters as the sixth cervical of *Eumetopias*, are included in this collection The larger of the two lacks most of its processes, but the other one is fairly complete The latter lacks, however, both epiphyses and both diapophyses; the right postzygapophysis is missing and the left transverse process is incomplete In general shape this fossil cervical exhibits a surprising resemblance to the sixth cervical of *Eumetopias*, but the forward inclination of the neural spine is less pronounced, the prezygapophyses are wider apart, and the postzygapophyses have more oblique articular facets Viewed from the front (fig 13) the neural canal is broader, the lateral vertebrarterial canals are larger, and the centrum is broader The lateral aspect (fig

Measurements of Cervical Vertebræ (in millimeters)

	Greatest depth (vertically), tip of neural spine to inferior face of centrum	Distance across vertebra between tips of transverse processes	Distance across vertebra between tips of diapophyses	Distance across vertebra between outside margins of anterior articular facets	Least antero-posterior diameter of superior surface of neural arch	Length of centrum	Least antero-posterior diameter of neural arch	Distance between outside margins of prezygapophyses	Tip of prezygapophysis to tip of postzygapophysis
Atlas, *Eumetopias jubata*, No. 7140, U S N M , ad ♂	82.5	205.6		91.2	37.5	32.5			
Atlas, *Allodesmus kernensis*, No 4398, C.A S	75.5	169 +		102.5	38.5	33.5			
Axis, *Eumetopias jubata* No 7140, U S N M , ad ♂	124.8	112.5		86.0		103.2	33.5		
Axis, *Eumetopias jubata*, No 21537, U S N M	91.8	76.4		72.0		74.0	25.0		
3rd cervical, *Eumetopias jubata*, No 7140, U S N M , ad ♂	104.2	157.0				76.3	43.5	89.0	104.0
3rd cervical, *Eumetopias jubata*, No 21537, U S N M	81.3	114.7				58.2	34.3	70.0	86.5
3rd cervical, *Allodesmus kernensis*, No 4409, C.A.S						49.2			
4th cervical, *Eumetopias jubata*, No 7140, U S N M , ad ♂	109.0	136.0	161.8			77.5	37.0	95.5	105.4
4th cervical, *Eumetopias jubata*, No 21537, U S N M	78.4	103.8	121.0			60.2	30.8	71.5	87.7
4th cervical, *Allodesmus kernensis*, No 4410, C A.S						47.0	17.5		
5th cervical, *Eumetopias jubata*, No 7140, U S N M , ad ♂	119.0	135.4	164.9			83.5	41.4	96.2	107.8
5th cervical, *Allodesmus kernensis*, No 4407, C A.S							35.7	102.2	91.8
5th cervical, *Eumetopias jubata*, No 21537, U S N M	88.4	105.0	119.2			66.8	32.3	80.3	87.2
5th cervical, *Allodesmus kernensis*, No 4411, C.A S						52.5			
6th cervical, *Eumetopias jubata*, No 7140, U S N M , ad ♂	138.8	116.8	160.1			89.5	42.0	100.0	106.8
6th cervical, *Allodesmus kernensis*, No 4399, C.A.S	106 +	106.0					34.5	110.8	90.9
6th cervical, *Eumetopias jubata*, No 21537, U S N M	106.8	86.3	113.2		..	71.8	30.0	83.5	86.3

14) is likewise similar, but the transverse processes are much less expanded antero-posteriorly, and the centrum is relatively shorter

The first dorsal (No 4412, C A S) is represented by an eroded centrum, and a portion of the neural arch on the right side. The centrum is much larger than that of the corresponding dorsal of *Eumetopias,* and the base of the neural arch is shorter antero-posteriorly Three additional vertebræ are referred to this pinniped, two of which belong near the anterior end of the series and one near the posterior end Although the first two (Nos 4417, 4416, C A S.) appear to belong somewhere between the fourth and sixth cervicals, this allocation is tentative, for the centra lack posterior facets for the heads of ribs The neural arches of these two dorsal vertebræ are quite thin, and the neural canals are rather large The neural spines, as well as the pre- and post-zygapophyses, are missing The centra of all three of these dorsal vertebræ are in a good state of preservation and resemble those of *Eumetopias jubata* A dorsal vertebra (No 4421, C A S) with a long centrum and oblique prezygapophysial facets seems to belong near the posterior end of the series, judging from the vertebral column of *Eumetopias,* but there is no certainty that this allocation is correct The neural arches are much higher than those of corresponding dorsals of *Eumetopias,* there is an eroded enlargement on the antero-lateral face of the centrum below the neural arch, in the position where the facet for the head of the rib should be located, and there is no indication of a facet for the tuberculum The neural spine and postzygapophyses are missing, and the prezygapophyses are damaged

Six incomplete vertebræ from much smaller individuals present peculiarities which are either attributable to age or sex Portions of the right and left halves of the atlas (No 4484, C A S) show that this cervical has the same general shape as those of larger individuals The facets for the odontoid process and centrum of the axis, and for the condyles of the skull are quite similar, but the anterior half of the vertebrarterial canal is closed. The third cervical (No. 4409, C A S) lacks most of the neural arch, the neural spine, and all of the zygapophyses with the exception of the left prezygapophysis

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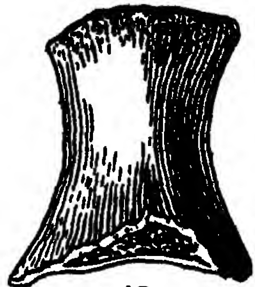

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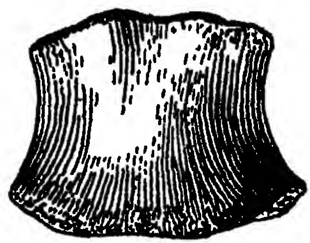

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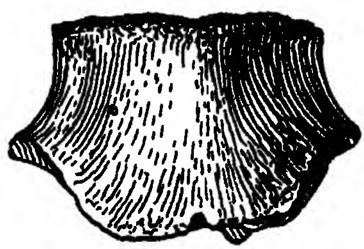

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Segments of sternum of *Allodesmus kernensis*, × 0 55 Fig 15 Presternum, No 4403, C A S Fig 16 First segment of mesosternum, No 4405, C A S Fig 17 Fifth segment of mesosternum, No 4402, C A S Fig 18 Sixth segment of mesosternum, No 4404, C A S

The centra of this and succeeding cervicals are more cylindrical than those of larger individuals, but similar sexual differences are observed in the living sea lion, and the ventral keel is well developed on all of them The left prezygapo-

physis is placed rather low and corresponds in shape and direction to that of *Eumetopias* The fourth cervical is likewise incomplete, the neural arch and its processes being missing Both transverse processes lack their extremities The fifth cervical (No. 4411, C A S) lacks all of its processes with the exception of a portion of the left transverse process The lateral vertebrarterial canal is large and the base of the diapophysis is rather narrow The base of the transverse process is about as wide, relatively, as in larger individuals The first dorsal (No 4418, C A S) has a centrum similar in shape to those of the cervicals, but curiously enough it retains an incompletely closed lateral vertebrarterial canal The facet for the tuberculum of the rib is placed on the latero-inferior face of the extremity of a large process arising from the neural arch The remainder of the neural arch and its processes are missing The centrum is slightly eroded in spots, but otherwise quite complete, and is somewhat longer than the cervicals The centrum of what appears to be the second dorsal (No 4419 C A S) is referred to this species It is slightly longer than that of the first dorsal With the exception of the lateral concavities there appears to be nothing unusual about this centrum

Sternum

The sternum seems to have been composed of eight pieces as in *Eumetopias* and *Odobenus* The presternum (fig 15) is rather long and narrow, abruptly expanded near the middle for the attachment of the first pair of sternal ribs and terminating in a spatula-like anterior projection The posterior half of the presternum tapers anteriorly to the constriction behind the point of attachment for the first pair of sternal ribs and is expanded distally The first segment of the mesosternum (No 4405, C A S) is longer than wide and contracted mesially The succeeding sections (Nos 4430, 4428, 4429, 4402, 4404, C. A S) are broader than long The last segment of the mesosternum (fig. 18) is expanded distally to provide a three-sided posterior face, the median one for articulation with the xiphisternum and each of the others for the

insertion of the last two sternal ribs on each side The xiphisternum was not identified among the various miscellaneous fragmentary bones found in this collection.

Measurements of the Sternal Bones

Total length of presternum (No 4403, C A S)	164 0 mm
Transverse diameter of posterior end of presternum (estimated)	55 0 mm
Transverse diameter of presternum at constriction	26 0 mm
Greatest length of first segment of mesosternum (No 4405, C A S)	69 0 mm
Greatest length of second segment of mesosternum (No 4430, C A S)	61 0 mm
Greatest length of third segment of mesosternum (No 4428, C A S)	57 0 mm
Greatest length of fourth segment of mesosternum (No 4429, C A S)	58 5 mm
Greatest length of fifth segment of mesosternum (No 4402, C A S)	56 0 mm
Greatest length of sixth segment of mesosternum (No 4404, C A S)	57 0 mm

SCAPULA

An incomplete left scapula (No 11857, U S N M) is referred to this fossil otariid The superior border, the posterior half of the blade, and the spine are missing None of the living Otariidæ possess a scapula of this type One of the most unusual peculiarities of the bone is the outward curvature of the prescapular portion of the blade A prominent broad ridge extending upward from the neck toward the vertebral border separates the deep prescapular fossa from an obviously similar postscapular fossa The neck of this scapula (fig 19) is unusually long The glenoid cavity is large, strongly concave, with its posterior diameter more than twice the width of the anterior diameter Neither the acromion nor the coracoid process are present

Measurements of the Scapula

Antero-posterior diameter of glenoid cavity	61 0 mm
Greatest transverse diameter of glenoid cavity	42.+mm
Posterior margin of broad subvertical ridge to antero-inferior angle of blade (measured at the same level)	110 0 mm

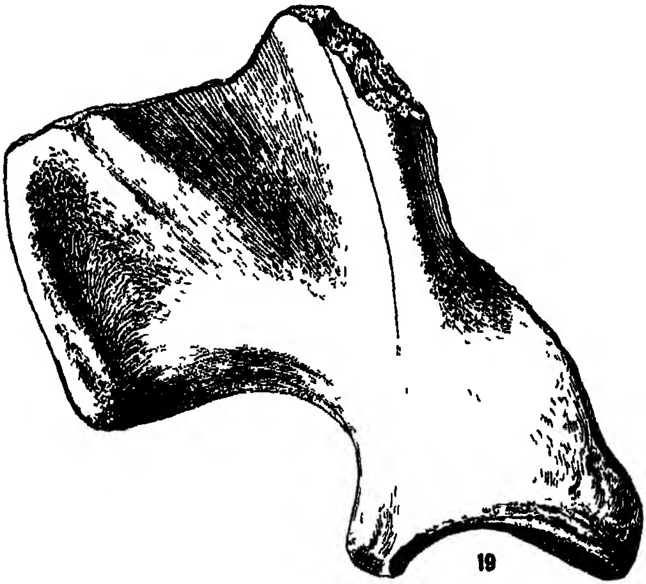


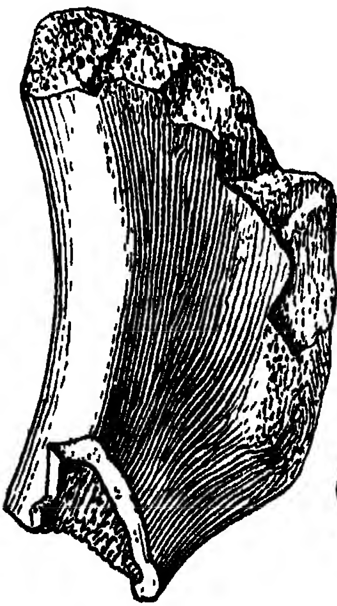
Fig 19 Incomplete left scapula of *Allodesmus kernensis*, No 11857, U S N M, × 0 5

Humerus

Distal and proximal fragments of a right humerus (Nos 4337, 4338, C A S), which may be portions of one bone, and the distal epiphyses of a very large left humerus (No 11858, U S N M) are all that are known at present The distinguishing characteristics of this fossil humerus may be summed up as follows (1) the inner condyle is placed very low, judging from its proximity to the distal margin of the inner trochlea, (2) the anterior border of the deltoid crest does not overhang the shaft to any appreciable extent on the outer side, (3) the longitudinal ridge below the lesser tuberosity is feebly developed, (4) the transverse diameter of the posterior face at the proximal end of the shaft exceeds by one-sixth the antero-posterior diameter of the shaft below the deltoid crest, and (5) the upper portion of the shaft is rather slender in comparison to that of *Eumetopias* The proportions of these fragments suggest a humerus of approximately the same size as that of a female or young male *Eumetopias jubata*

Viewed from the front the shaft tapers gradually toward the distal extremity, and the proximal end is unusually narrow as compared to its length The entire proximal epiphysis, including the head and the greater and lesser tuberosities, is missing The deltoid ridge (fig 20) is rather high, and, although its anterior border is somewhat eroded, there is nothing to indicate that the external margin was produced outward as in *Eumetopias* At the distal end, the deltoid crest rises rather abruptly, and the anterior margin for most of its length is straight as viewed from the side The posterior face of the proximal one-third curves strongly backward

The trochlear surface (fig 21) for articulation with the bones of the forearm is divided as usual into two main areas The outer convex capitulum which articulates on the head of the radius, and the inner trochlea which rests in the greater



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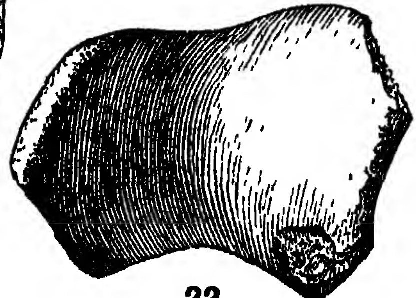

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Fragments of humeri of *Allodesmus kernensis*, × 0 5 Fig 20 External view proximal end of shaft of a right humerus, No. 4337, C A S Fig 21 Distal view of a right humerus, No 4338, C. A. S Fig 22 Distal view of a left humerus, No 11858, U. S. N M

sigmoid cavity of the ulna, do not differ in any essential feature, when viewed from the front, from the corresponding surfaces of the humerus of *Eumetopias*. On the posterior face, however, the trochlea is considerably narrower. The width of the trochlear surface on the large left humerus (fig 22) exceeds 98 mm, and thus exceeds the width of a very large old male *Eumetopis jubata*.

Measurements of Humeri (in millimeters)

	No 11858, U.S N M Left, *Allodesmus kernensis*	No 4338, C A. S Right, *Allodesmus kernensis*	No 4337, C A. S. Right, *Allodesmus kernensis*	No 21537, U S.N M Left, *Eumetopias jubata*
Width of trochlear surface on the anterior face	97 +	73 0		73 5
Width of trochlear surface on the posterior face		51 0		70 8
Transverse diameter of shaft below head			55 5	91 0
Antero-posterior diameter of shaft near the middle (through deltoid crest)			68 5	74 5

RADIUS

In spite of their weathered and eroded condition, certain peculiarities, in addition to size which may or may not be of importance, appear to differentiate into two categories the radii represented in the material submitted for study The writer, nevertheless, is not disposed to stress the importance of characters observed on the proximal ends of the two radii belonging to large individuals (Nos 4293, 4406, C A S) and the corresponding portions of radii of three smaller individuals (Nos 4291, 4292, C A S, and No 11863, U S N M) The heads of all these radii are more or less eroded and consequently the original contour of the proximal surface can not be determined with any degree of certainty At the level of the bicipital tuberosity, the necks of the radii would appear subtriangular in cross section The upper ulnar facet of one of the smaller radii (No 4292, C. A S.) measures 17 mm in depth and the same measurement for one of the larger radii (No 4406, C A S) is 26 6 mm

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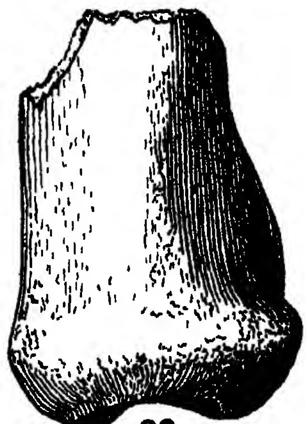

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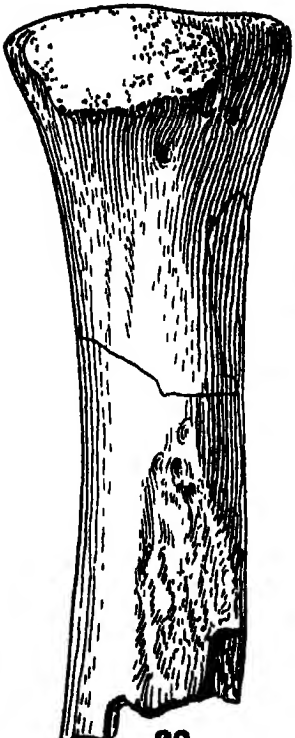

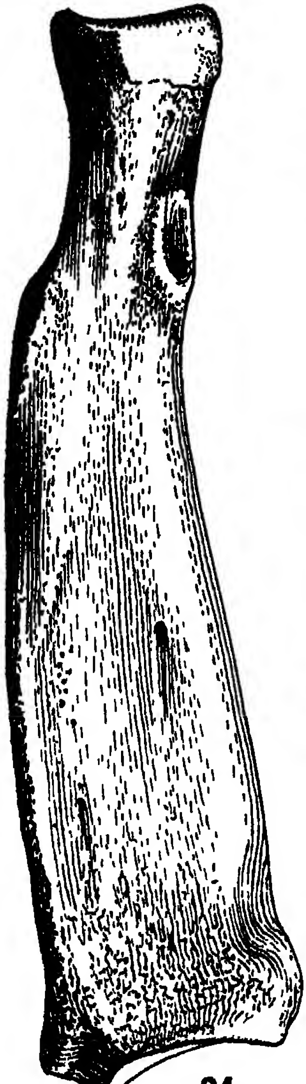

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Radii of *Allodesmus kernensis*, × 0.5 Fig. 23 Posterior view of right radius, No. 4406, C. A. S. Fig. 24 Internal view of right radius, No. 4292, C. A. S. Fig. 25 Distal view of right radius, No. 4292, C. A. S. Fig. 26 External view of right radius, No. 11866, U. S. N. M. Fig. 27 Distal view of right radius, No. 11866, U. S. N. M.

Compared with the radii of *Eumetopias jubata*, these fossil radii are much longer and slenderer, less expanded at the level of insertion of *pronator radii teres*, and have a larger facet for distal end of ulna, a more squarely truncated anterior border of facet for scapho-lunar, and a more distal position for the bicipital tuberosity. The right radius (fig. 24) of a smaller individual is fairly complete, but the distal extremity is somewhat eroded. The distal one-third of a right radius (fig. 25) is better preserved. In addition to these two there are portions of the proximal ends of three right radii of animals of approximately the same size.

The following features seem to characterize the radius in smaller individuals: (1) the narrowness of the shaft at the level of the insertion of the *pronator radii teres*, (2) the long neck, (3) the presence of a broad depression on the posterior face of the shaft for the insertion of the interosseous ligament, and (4) the low position of the bicipital tuberosity.

On the other hand, the radius in larger individuals has (1) a much thicker neck, (2) the large facet for the capitulum of the humerus occupying practically the entire proximal surface of the head, and the trochlear facet limited to a narrow border on the internal side, and (3) a less distinct bicipital tuberosity.

Measurements of Radii (in millimeters)

	No. 4291, C. A. S. Right, *Allodesmus kernensis*	No. 4292 C. A. S. Right *Allodesmus kernensis*	No. 11866, U.S.N.M. Right *Allodesmus kernensis*	No. 11863, U.S.N.M. Right *Allodesmus kernensis*	No. 7140 U.S.N.M. Right, *Eumetopias jubata*	No. 4406, C. A. S. Right, *Allodesmus kernensis*
Greatest length of radius		264.0			298.0	
Greatest diameter of radius at proximal end	54.5	54.4		49.5	72.5	69.3
Greatest diameter of radius at distal end		67.5+	72.0		95.0	
Breadth of radius across bicipital tuberosity	27.0	31.0		32.0	42.5	

ULNA

The left ulna (No 4335, C A S) of this pinniped is remarkable for its massiveness and for its length It is similar in general shape to the ulnæ of *Eumetopias* and *Odobenus*, but differs from both in several important details The greater sigmoid cavity (fig 29) is much narrower transversely, and there is no free border on the internal and proximal sides On an ulna of *Odobenus* and *Eumetopias* the free border of this cavity is noticeably prolonged beyond the inner and anterior surfaces of the shaft The lesser sigmoid cavity corresponds in shape and position with that on the ulna of the walrus and sea lion

On the internal face of the ulna (fig 28) is an elongate depression for the flexor muscle of the digits, but this area does not extend so far distally as it does on the ulna of the walrus Below the greater sigmoid cavity, on the anterior face of the ulna, is a rugose indentation for muscular attachment The anterior brachialis muscle is inserted in this area on the ulna of the walrus On the internal surface adjacent to and below this area is an elongate depression for another muscle In case of the ulna of the walrus and the sea lion, there is a conspicuous rugose surface for muscular attachment which appears comparable to that on this fossil ulna, but it extends across the antero-internal angle of the shaft The middle portion of the inner surface of the shaft is flattened and the distal portion is slightly concave

The curvature of the outer face of the shaft resembles that of *Eumetopias* The margins of the olecranon process are eroded and the proximal epiphysis is missing The anterior border of the olecranon process of this fossil ulna is greatly thickened and the posterior border is rather thin The shaft of the ulna attains its maximum thickness at the distal end where it would appear oval in cross section The distal epiphysis of this ulna with its facets for the radius, pisiforme, and ulnare is lost

Fortunately a distal epiphysis (fig 30) of the right ulna of a smaller animal is available for comparison The facet for the radius is considerably larger than the corresponding facet on the ulna of the walrus The distal end of this epiphysis is produced and is furnished with a large oval facet for articula-

28

29

30

Incomplete ulnæ of *Allodesmus kernensis*, × 0.5 Fig 28 Internal view of left ulna, No 4335, C. A. S. Fig 29 Anterior view of left ulna, No 4335, C. A. S. Fig 30 Anterior view of distal extremity of right ulna, No 4336, C. A. S.

tion with the ulnare This facet is rather rugose and may have been covered with some sort of a capsular cartilage Judging from the size of the irregular facet on the inner face of this epiphysis, the pisiforme was a rather large bone

Measurements of Ulnæ (in millimeters)

	No 4315, C A S Left, *Allodesmus kernensis*	No 21331, U S N M Left, *Odobenus divergens*	No 7140, U S N M Left, *Eumetopias jubata*
Greatest length	365 0*	360 0	373 0
Greatest vertical diameter of greater sigmoid cavity	59 7	77 3	59 5
Greatest transverse diameter of greater sigmoid cavity	44 0	62 0	71 0
Greatest antero-posterior diameter of olecranon process	90 +	113 6	124 5
Greatest antero-posterior diameter of distal extremity of shaft	53 2	51 0	45 0
Greatest antero-posterior diameter of shaft at level of distal margin of greater sigmoid cavity	96 5	77 5	81 0

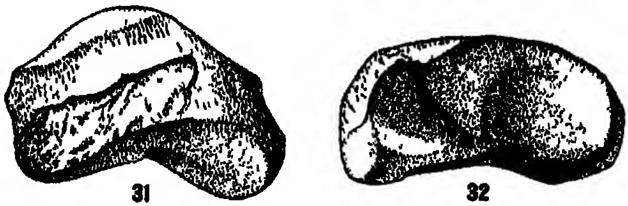
* Distal epiphysis missing

CARPUS

As in living pinnipeds, the carpus of *Allodesmus kernensis* is more broadened and flattened than in terrestrial carnivores The scaphoid, lunar, and probably the centrale have fused to form one transversely elongated bone The ulnar side of the carpus is shortened as in living otariids and the unciform is rather small The magnum resembles the same bone in the carpus of *Eumetopias jubata* and a similar resemblance exists between the trapezium and unciform bones of these two pinnipeds The other carpal bones are as yet unknown The fifth metacarpal articulates with the ulnare and the external face of the unciform This metacarpal is much shorter than any of the others

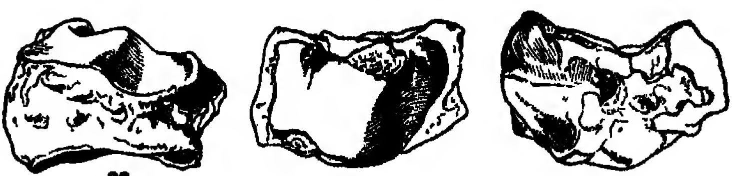
Scapho-Lunar

Three right scapho-lunar bones are included in this collection, two (No 4332, C A S, and No 11859, U S N M) of which belong to very large individuals and one (No 4369, C A S) to a somewhat smaller individual, as is shown by the measurements The two large carpals are somewhat eroded, but the smaller scapho-lunar with the exception of the radial border is well preserved The writer is not quite certain that these large scapho-lunar bones belong to this pinniped, for the curvature of the radial articular surface is quite different from that of the smaller carpal The internal half of the radial articular surface (fig 33), although shallowly concave, is somewhat shorter than on the larger scapho-lunar bones, and the external half (fig 34) has a broad flat depressed border in contrast to the rounded surface of the larger bones The smaller scapho-lunar is characterized by the convexo-concave curvature of the radial articular surface, the narrow articular surface for the trapezium and trapezoid, and the presence of a prominent plantar tuberosity (fig 35) internal to the facet for the unciform The radial articular surface of the larger scapho-lunar bones have a more regular convex curvature, a



31 32

Right scapho-lunar of (?) *Allodesmus kernensis*, No 4332, C A S, × 0.5 Fig 31 Anterior view Fig 32 Distal view



33 34 35

Right scapho-lunar of *Allodesmus kernensis*, No 4369, C. A. S., × 0.5 Fig 33 Anterior view Fig 34 Posterior view Fig. 35 Distal view

broader articular surface for the trapezium and trapezoid (fig. 32), and may lack the plantar articular tuberosity internal to the facet for unciform, but this surface is eroded on both carpals.

In general form these carpals are similar to the scapho-lunar of *Eumetopias jubata*, but the radial articular surface is much larger The facets on the proximal and distal faces of this bone show that it was the largest of the carpal bones. The large convex articular facet which supports the radius covers most of the proximal surface As compared with the same facet on the scapho-lunar of *Eumetopias*, this articular surface is fully one-third wider Viewed from above, the ulnar border of this fossil scapho-lunar corresponds with the carpal of *Eumetopias*, but the radial border is conspicuously shorter There are facets on the distal surface (fig 32) for four of the carpal bones An oblique crest crossing the distal surface from the antero-ulnar angle to the postero-radial angle separates the facet for the magnum from that for the trapezoid On the scapho-lunar of *Eumetopias* there is one large continuous articular surface, concave from side to side, which rests upon the trapezium and the trapezoid This fossil carpal has a similar articular surface, but the facet for the trapezium is depressed posteriorly The facet for the magnum is relatively smaller than in *Eumetopias* and terminates on a prominent plantar tuberosity, the facet on the ulnar border for the unciform is less concave

Measurements of Scapho-Lunars (in millimeters)

	No 4369, C A S Right, *Allodesmus kernensis*	No 4332, C A S. Right, *Allodesmus kernensis*	No 11859, U S N M Right, *Allodesmus kernensis*	No 21537, U S N M Right, *Eumetopias jubata*
Greatest transverse diameter	60 +	78 0	76 +	81 0
Greatest proximo-distal diameter	43 3	49 0	48	44 5
Greatest transverse diameter of combined facets for trapezium and trapezoid	50 +	66 0	62 +	51 2
Greatest transverse diameter of radial facet	49 0	60 8	56 5	44 5

Trapezium

Aside from its smaller size, the left trapezium (No. 4331, C. A S) referred to this pinniped bears a rather close resemblance to the corresponding carpal of a larger individual described in a previous paper [14] Comparison with the trapezium of *Eumetopias jubata* shows that this carpal is relatively narrower in a dorso-plantar direction, the tuberosity on the radial face is placed much higher, the facets for the navicular and trapezium have a different declination, and the direction of the radial tuberosity causes the plantar face to appear concave

The large radial tuberosity is furnished with an elliptical articular surface, presumably for a sesamoid The facet for the trapezoid is double, the main facet extending from the proximal to the distal margin, and adjoining it on the distal border is the lesser facet whose shape is more or less hemicircular The trapezium has a large concave facet on the distal face for the second metatarsal. The facet for the scapho-lunar curves downward toward the radial face as in *Eumetopias,* but the slope is less abrupt The dorsal surface is flattened and somewhat roughened

Measurements of Trapezia (in millimeters)

	No 4331, C A S. Left, *Allodesmus kernensis*	No 21537, U S N M Left, *Eumetopias jubata*
Greatest proximo-distal diameter	28 4	32 4
Greatest transverse diameter	34 7	33 4
Greatest dorso-plantar diameter	25 1	31 6
Greatest proximo-distal diameter of radial tuberosity	20 5	14 3

Magnum

The right magnum (No 11860, U. S. N. M) of a large individual differs from the corresponding tarsal of a large old

[14] R Kellogg, Univ Calif Publ, Bull. Dept. Geol. Sci., vol 13, no. 4, 1922, pp 36-37, text figs. 11a 11b.

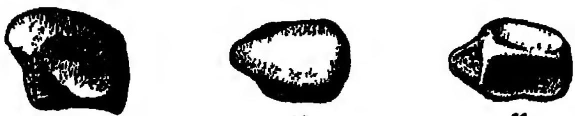
36 37 38

Right magnum of *Allodesmus kernensis*, No 11860, U S N M, × 0.5. Fig 36 Proximal view Fig 37 Distal view Fig 38. Internal view

male *Eumetopias jubata* chiefly in the curvature of the facets for articulation with the trapezoid, scapho-lunar, and unciform The convex facet for the scapho-lunar is very narrow anteriorly, almost crest-like, and is broadest posteriorly On the internal face is a concave facet for the trapezoid and on the external face is a much longer facet for the unciform, which follows the superior and anterior borders of the bone. The distal facet for the third metacarpal is quadrangular in outline and strongly concave in a dorso-plantar direction The posterior face of this bone is much narrower than that of the living sea lion

Measurements of the Magnum

Greatest dorso-plantar diameter	45 5 mm.
Greatest transverse diameter	22.8 mm
Greatest proximo-distal diameter	31.5 mm



39 40 41

Right unciform of *Allodesmus kernensis*, No 11862, U S N. M., × 0.5 Fig 39 External view Fig 40 Proximal view Fig 41 Distal view

Unciform

The right unciform (No 11862, U S N M) of a somewhat smaller individual has the same general conformation as the corresponding carpal of *Eumetopias*, but the internal face is relatively higher It has large proximal facets for the

scapho-lunar and ulnare, a narrow facet for the magnum which follows the upper and anterior borders, and a large external facet for the fifth metacarpal The facet for articulation with the scapho-lunar is flattened and elongated, while that for the ulnare is noticeably convex The distal facet for the fourth metacarpal is strongly concave

Measurements of the Unciform

Greatest dorso-plantar diameter	34 0 mm
Greatest transverse diameter	24 5 mm.
Greatest proximo-distal diameter	26.8 mm.

Metacarpals

Several large metacarpals and phalanges are assumed to belong to an old male They are structurally the same as those of smaller individuals which are described herewith

The fifth left metacarpal (No 4480, C A S) lacks the distal extremity and seems to be deformed or pathological The posterior surface of the shaft and head resemble those of diseased bones of the living sea lion As with smaller individuals the facet for articulation with the ulnare is horizontal and that for the unciform is oblique

The right (No 4481, C A S) and left No 4478, C A S) second metacarpal bones agree with those of smaller individuals in their general features, but are much larger and heavier bones The proximal surface for articulation with the trapezoid curves from the plantar to the dorsal margin, and slopes from the external to the internal face There is a large antero-proximal facet for articulation with the head of the third metacarpal

Two very large metapodials (Nos 4476, 4477, C A S) are referred to this species They belong to opposite limbs and may be from one individual They are much shorter and heavier than the first metacarpals of any living otariid and may possibly belong in the first row of phalanges The proximal ends are eroded to such an extent that the character of the facets can not be satisfactorily determined The facet on the distal extremity is strongly convex The shafts of these bones are flattened in a dorso-plantar direction and expanded laterally Two smaller bones (Nos 4479, 4483, C. A S.), which

appear to be phalanges, are referred to this pinniped. One of these is similar in appearance to the larger bones described above

A number of smaller metacarpals and phalanges are also referred to *Allodesmus kernensis* One of them (No 4482, C. A S) seems to be the terminal phalanx of the first digit of the manus

As compared with those of *Eumetopias jubata*, the phalanges of the fore and hind limbs of this fossil pinniped are not only much wider, but the shafts are remarkedly flattened The eight phalanges referred to this pinniped are shorter than corresponding bones of *Eumetopias*, but the articular surfaces on the proximal and distal ends of the shafts present the same structural peculiarities

The following metapodials belong to somewhat smaller individuals Both of the fifth right metacarpals bones referred to this pinniped are somewhat eroded They are about the same size as those of *Eumetopias jubata* The length and the transverse diameter of the shafts are approximately the same, but the shaft of the fossil metacarpal would appear triangular in cross section The facets for articulation with the ulnare and unciform form one continuous oblique surface on the fifth metacarpal of *Eumetopias* On the fossil metacarpal, the facet for the ulnare is horizontal and that for the unciform is oblique The articular surface on the distal end of the shaft is broad and rounded, but has a deep concavity on the interno-plantar angle

The fourth right metarcarpal bone (No 4458, C A S) can be articulated with the fifth metacarpals described above It is slightly larger than the corresponding metacarpal of *Eumetopias jubata* The head is large and rounded, with an oblique anterior facet for the magnum and a strongly convex proximal facet for the unciform The plantar extension of the head is narrowed and directed inward as in *Eumetopias*, and the proportions of the shaft are likewise similar

The third metacarpal bones hereinafter discussed may possibly represent two species of fossil pinnipeds and belong at least to individuals which differ considerably in size. These bones range in length from 72 8 mm to 93 0 mm In so far as the proportions of the shafts and the shape and extent of

Measurements of Metacarpals (in millimeters)

	I C A. S No. 4465	I C A S No 4466	III C A S. No. 4459	III C. A S. No 4460	III C A. S No. 4461
Greatest length			73 5	72 8	80 0
Dorso-plantar diameter of head	28 +	41 0	25 8	21 4	27 4
Transverse diameter of head	32 5	40 0	23 4	20 0	24 4
Narrowest transverse diameter of shaft			15 2	13 3	13 3
Transverse diameter of distal end			22 4	19 2	23 5

	III C A S No 4462	III C A S No 4463	IV C. A S No 4458	V C A S No 4451	V C A S No 4467
Greatest length		92 8	72 8	63 5	59 8
Dorso-plantar diameter of head	26 6	27 0	26 7	24 8	22 5+
Transverse diameter of head	22 5	26 0	25 3	27 5+	26 +
Narrowest transverse diameter of shaft	13 2	14 5	16 8	19 5	17 0
Transverse diameter of distal end		27 5		25 8	23 +

the articular facets are concerned, they agree rather closely with one another The two larger bones (Nos 4462 and 4463, C A S) from the left and right manus, respectively, differ from the three smaller metacarpals in having the convex facet for the fourth metacarpal continuous with the proximal articular surface for the magnum On the three smaller metacarpals (Nos 4459, 4460, 4461, C A. S) this facet is subvertical in position and slightly concave The oblique flattened facet for the head of the second metacarpal is similar to that of *Eumetopias* The plantar extension of the head is somewhat narrower than in *Eumetopias* and the distal end of the shaft has a more rounded articular surface for the corresponding phalanx The second metacarpal is not represented in this lot of bones The right (16756, U C) and left (23170, U C) second metacarpal bones, which were described in a previous paper,[15] belong to an animal of approxi-

[15] R. Kellogg, Univ Calif Publ, Bull Dept Geol Sci, vol. 13, no 4, 1922, pp 37 39, figs. 12a c

mately the same size as that to which the larger pair of third metacarpals (Nos 4462, 4463, C A S) belongs One of these metarcarpals was erroneously described as the fourth metacarpal

The proximal ends of two first metacarpals from the left manus show that this bone was similar to the corresponding bone of *Eumetopias jubata* The facet for articulation with the trapezium crosses the head obliquely and the shaft is somewhat deeper than in *Eumetopias*

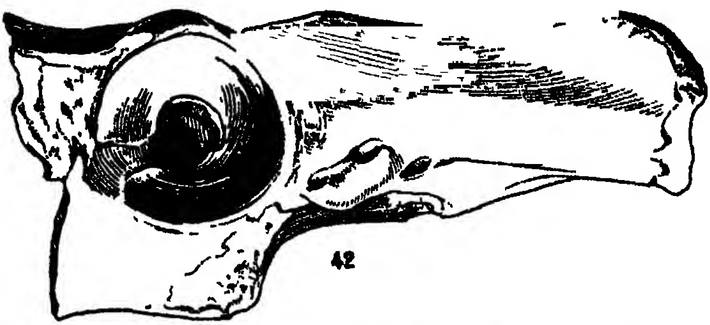


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Fig 42 Right innominate bone of *Allodesmus kernensis*, No 4360, C A S, × 0 5

PELVIS

A portion of the right innominate bone (No 4360, C A S) of a large individual is included in this collection The posterior half of this bone is missing (fig 42) As compared with the corresponding bone of *Eumetopias jubata*, the anterior portion or ilium is not so deep and it is less expanded at the extremity, but the depth through the acetabulum is much greater The greatest diameter of this fossil innominate bone through the acetabulum is 84 7 mm as contrasted with a corresponding measurement of 77 0 mm for an adult male *Eumetopias* The least dorso-ventral diameter of the ilium is 45 3 mm as compared to 55 0 mm in the case of *Eumetopias* The socket for the head of the femur is deep The ilium curves outward as in *Eumetopias* and there are two deep irregular depressions on the internal face for the corresponding sacral vertebræ

Measurements of Pelves (in millimeters)

	No 4360 C A S *Allodesmus kernensis* Temblor formation	No 7140, U S N M *Eumetopias jubata*, Ad ♂ St Paul Island, Alaska	No 7140, U S. N M *Eumetopias jubata*, Ad ♂, St. Paul Island, Alaska	No. 21537, U S N M *Eumetopias jubata*, Farallones Islands, west of San Francisco, Calif
	Right	Left	Right	Right
Greatest length		249 0	247 0	255 0
Anterior margin of acetabulum to anterior margin of ilium	115 5+	129 5	130 0	105 4
Posterior margin of acetabulum to posterior margin of ischium		178 0	177 0	120 2
Antero-posterior diameter of thyroid foramen		127 5	123 2	67 0
Symphysis of pubis to tuberosity of ischium		115 0	114 7	117 0
Greatest diameter of innominate bone through acetabulum	84 7	77 5	77 0	71 7
Least dorso-ventral diameter of ilium	45 3	54 5	55 0	51 3

Femur

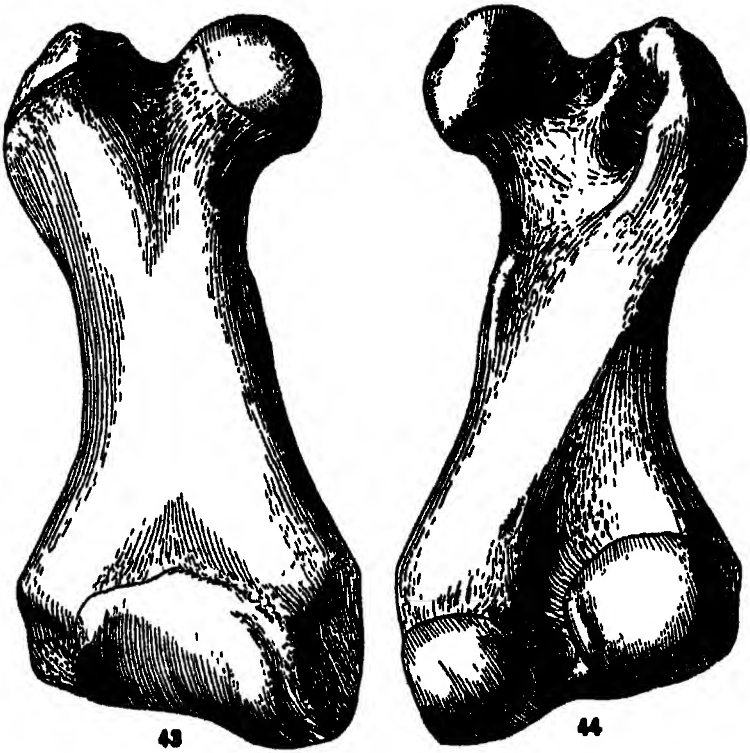
Among the various bones allocated to this fossil pinniped are femora of very large individuals, others from animals of medium size, and those which obviously belong to young The four which belonged to animals of moderate size consist of the proximal end of a right femur (No 4299, C A S), the distal extremity of a slightly larger right femur (No 4298, C A S), and the eroded distal extremities of a left (No 4301, C A S) and a right femur (No 4396, C A S) of approximately the same size as the first mentioned fragment The proportions of the proximal end of the shaft of the right femur indicate that this bone was more slender than the same bone of a larger individual (figs 43-44) There are also other differences and of these the following appear to be the most important (1) intercondyloid fossa almost as wide as the internal condyle, (2) a broad trochanteric crest which is not

limited internally by a tubercle, (3) a low crest-like lesser trochanter, with a depression above it, and (4) patellar surface limited to distal epiphysis

Two of the three femora, which are represented by the distal extremities, have the epiphyses firmly ankylosed to the shafts The proximal end of the right femur lacks the epiphysis which caps the shaft in the area of the greater trochanter As in *Eumetopias jubata*, the overhang of the head is most pronounced on the anterior and internal faces A little in front of the summit of the head is a large pit for the insertion of the *ligamentum teres* which is quite remarkable when one stops to consider that both the ligament and the depression are wanting on femora of living otariids The trochanteric fossa is quite deep, measuring about 20 mm across, and is continuous internally with the posterior surface of the neck No counterpart of the depression above the low crest-like lesser tuberosity could be found on the femora of any of the living members of the family Otariidæ The intertrochanteric crest is as distinct as in *Eumetopias jubata* Below this crest the posterior surface of the shaft is distinctly flattened The greater trochanter is broadest at the upper end and is distinctly narrowed distally The depression on the anterior face of the femur between the head and the greater trochanter is smooth and not pitted as in *Eumetopias*

At the distal end of the shaft, the external condyle is much larger than the internal, while in *Eumetopias* they are more nearly equal in size The most peculiar feature of the distal ends of these femora, however, is the relatively great width of the intercondyloid fossa The fossa for the posterior cruciate ligament is broad and that for the anterior ligament extends upward across the distal end of the shaft The epicondyles are similar to those of *Eumetopias*, but the convex patellar surface is depressed mesially The anterior face of the shaft above the patellar surface is not depressed as in the living otariids

When compared with those of living pinnipeds, it is at once apparent that the only feature of especial interest possessed by these femora is the presence of a pit for the *ligamentum teres* It is evident that these two large femora are intermediate in



Right femur of *Allodesmus kernensis*, No 4294, C. A S, × 0 5 Fig 43 Anterior view Fig 44 Posterior view

size between those of a very old male sea lion *(Eumetopias jubata)* and a female of the same species

Briefly stated, these large femora (figs. 43, 44) are characterized by the following combination of characters (1) presence of a large pit on the summit of the head for the insertion of the *ligamentum teres;* (2) presence of a large, deep trochanteric fossa on the inside of which is a well developed crest or tubercle presumably for the *gemellus superior,* (3) absence of any indication of an intertrochanteric crest, (4) rudimentary condition of the lesser trochanter; (5) a narrow and deep intercondyloid fossa; (6) external condyle considerably larger than the internal condyle, (7) a large area for the attachment of the anterior cruciate ligament, com-

parable in proportions to that of an old male *Eumetopias*, (8) patellar surface smooth, not depressed, and its superior border overspreads the distal end of the shaft; and (9) overhang of head about as in *Eumetopias*

In respect to the separation of the epiphyses from the shafts the approach is directly toward the conditions existing in the bones of an immature animal, but this condition occasionally exists in old individuals of *Eumetopias* Both of the femora of this large animal were found with the distal epiphyses separated from the shafts The proximal epiphyses were attached to the shafts, but the line of demarcation is very distinct In case of living sea lions and walruses, old individuals usually have the epiphyses ankylosed to the shafts and the line of contact is often obliterated It is true that the bones of two smaller individuals, which were associated with those of this animal, have the epiphyses fused to the shafts

Curiously enough, the shafts of both of these femora were fractured diagonally on a line running from the distal angle of the greater trochanter to a point above the internal epicondyle The right femur, which is the more nearly complete of the two, is remarkable for its relative width as compared to that of an old male of the living sea lion *(Eumetopias jubata)* The head conforms in shape to the usual subhemispherical articular surface which fits into the acetabulum, and is directed inward and slightly forward A little below the summit is an oval pit for the attachment of the *ligamentum teres* The head is supported by a short stout neck, and the overhang of the former is most pronounced on the anterior and internal faces

Posteriorly, where the neck unites with the shaft, there is a distinct intertrochanteric crest connecting the greater trochanter with the rudimentary lesser trochanter No tubercle is developed for the *quadratus femoris*, and the insertion of this muscle appears to have been extended upward upon the lower half of the posterior border of the greater trochanter The greater trochanter is a large, thin, semicircular epiphysis which caps the proximal end of the shaft and projects above the head This portion of the shaft is considerably larger than the head and is obliquely truncated externally On the posterior surface of the shaft is a deep trochanteric fossa, and, adjoining the fossa on the inside, is a rather prominent

tubercle or ridge, presumably for the insertion of the gemellus superior.

The lesser trochanter is rudimentary and consists of a low, short elevation crossing the postero-internal margin of the shaft in an oblique direction, and its main axis coincides with the usual direction of the intertrochanteric crest Both sexes of *Eumetopias jubata* have a well developed lesser trochanter

Viewed from in front, the face of the shaft is characterized by the rather even side-to-side curvature and the absence of any pronounced depression above the patellar surface, thus differing in the last mentioned respect from those of *Eumetopias* and *Odobenus* The shaft is narrowest at the level of the lesser trochanter and is most expanded at the distal end For descriptive purposes the internal surface of the shaft may be divided into a proximal portion extending as far as the usual position of the intertrochanteric crest, a narrow mesial portion lying between the latter and the ill-defined *linea aspera,* and the distal portion which extends from the latter to the condyles The mesial portion is shallowly depressed and above the intercondyloid fossa on the distal portion of the shaft there is a rather large rugose depression which serves for the attachment of the anterior cruciate ligament. No trace of arterial foramina such as are present in *Eumetopias* and *Odobenus* could be found on the postero-internal surface of the shaft.

Capping the distal end of the shaft is the epiphysis which presents the condyles and the patellar surface The articular surfaces of the condyles are continuous in front with the large patellar surface and are separated mesially by the deep intercondyloid fossa Viewed from their posterior aspect, the external condyle is seen to be the larger and the broader of the two The side-to-side convexity of the external condyle is much more pronounced than is the case with the internal The external epicondyle presents a rough, elevated surface, but the internal epicondyle is depressed The margins of the patellar surface are worn and one can not determine to what extent they were raised above the surrounding bony epiphysis.

In addition to this pair of large femora there are also a smaller pair (Nos. 4296, 4297, C A S) which obviously belong to a young animal These bones have the epiphyses missing at both ends of the shaft They measure 125 and 126

Measurements of Femora (in millimeters)

	No 21331, U S N M Ad Right, *Odobenus divergens*	No 7140, U S N M Ad. Left, *Eumetopias jubata*	No 4294, C A S Ad Right, *Allodesmus kernensis*	No 4295, C A S Ad Left *Allodesmus kernensis*	No 7156, U S N M Yg Left, *Odobenus divergens*	No 4296, C A S Yg Right, *Allodesmus kernensis*	No 4297, C A S Yg Left, *Allodesmus kernensis*	No 4298, C A S Ad Right, *Allodesmus kernensis*	No 4299 C A S Ad Right, *Allodesmus kernensis*	No 4100, C A S Ad Right *Allodesmus kernensis*	No 11537, U S N M Ad Right *Eumetopias jubata*	No 16750, U C Yg Left, *Allodesmus kernensis*	No 16755, U C Yg Right, *Allodesmus kernensis*
Greatest length (head to internal trochlea)	244.8	220.0	198.3	197.5[1]	146.4	125.0[2]	126.0[2]			140.4	167.4	132.2	
Greatest transverse diameter of proximal end (head to greater trochanter)	114.0	91.7	94.3	95.0					80.0	74+	67.8		
Extero-internal diameter of shaft at narrowest point	65.6	44.2	48.5	48.2	41.8	35.5	35.4			36.4	36.5	37.4	
Greatest transverse diameter of distal end (internal to external epicondyla)	113.0	88.7	95.0					88.0			71.8		78.0
Greatest diameter of head	52.7	41.5	43.0	43.2					37.5		35.5		
Greatest transverse diameter of external trochlea	41.6	36.0	41.7	40.5				37.4			29.0		26.1
Greatest transverse diameter of internal condyle	36.3	34.2	32.4	33.7							28.4		32.5
Breadth of intercondyloid fossa at narrowest point	18.4	21.5	15.4	15.1				20.8			15.3		
Breadth of distal end of shaft		88.5		86.0	73.8	76.8	73.3			53+	73.8	66.7	
Breadth shaft at proximal end		85.1			83.2	72.8						69.4	

[1] Distal epiphysis missing.

[2] Both epiphyses missing.

mm in length, respectively. Before taking up in detail a consideration of these smaller femora, it seems advisable to discuss their relationship to another femur[16] described from the same deposits in a previous paper It is now apparent that the left femur associated with the type mandible of *Allodesmus kernensis* belongs to a young individual and that in all probability it does not belong to the same individual as the jaw This femur, unlike the two hereinafter described, has a fairly distinct intertrochanteric crest These smaller femora present all the salient features of the larger femora described above Anteriorly the shaft is more or less flattened at the distal end and proximally the surface slopes to the outer border, giving the shaft a twisted appearance Turning to the posterior face we find that there is no indication of an intertrochanteric crest and that the lesser trochanter is represented by a low elevation The trochanteric fossa is well defined, but the internal crest, or tubercle, which is developed on the larger femora, is missing The depression at the distal end of the anterior cruciate ligament is well defined In comparison with those of the larger femora, the neck, which supports the head, appears to be proportionately thicker than the portion of the shaft which bears the greater trochanter

Patella

The knee joint of this fossil pinniped was protected by a large patella The base of this sesamoid bone is more or less quadrangular in outline and is furnished with a large, oval, concave, articular surface whose main axis is oblique to the proximo-distal axis of the patella itself The distal angle of this bone is drawn out into a rounded peak, and the major portion of the anterior surface slopes to the proximal margin Beginning near the middle of the external border and curving around the distal face is a broad groove for some ligament A similar groove, with less sharply defined margins, is present on the internal border Nine patellæ ranging in size from one with a proximo-distal diameter of 62 5 mm to one measuring not more than 45 mm were sorted out of this collection At the distal end, the largest of these sesamoids has a depth of

[16] R Kellogg Univ Calif Publ Geol Sci, vol 13, No 4, 1922, pp 39 40, text figs. 14a 14b

45

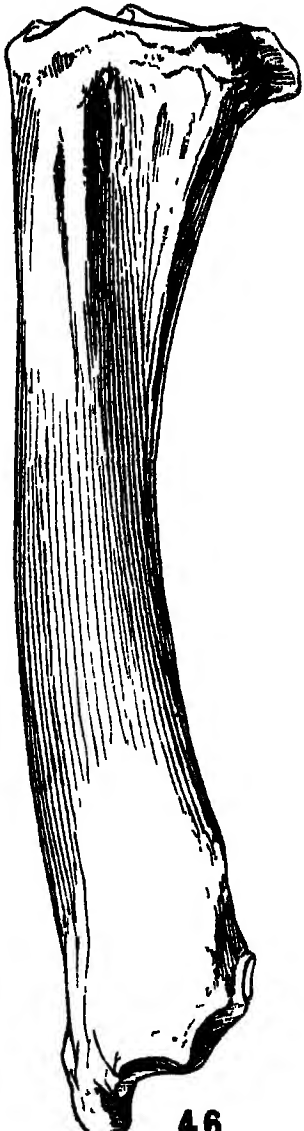
Fig 45 Patella of *Allodesmus kernensis*, No 11544, U S N M, × 0 5

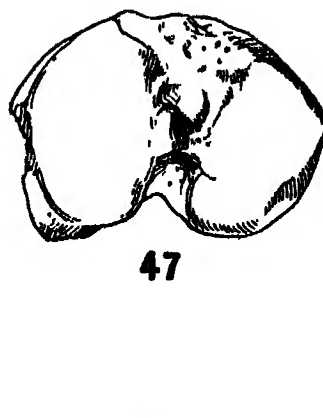
41 2 mm and the corresponding measurement for the smallest is 30 4 mm Most of these sesamoids are more eroded than the one here figured (fig 45)

TIBIA

Comparison with the tibiæ of living otariids indicates that the tibia (No 4304, C A S) of young males or females of *Allodesmus kernensis* may be distinguished by the following combination of characters (1) shaft irregularly three-sided, but without distinct anterior longitudinal crest, (2) proximal end of shaft not fused with head of fibula, (3) posterior surface of shaft distinctly flattened, (4) posterior intercondyloid fossa relatively small and anterior intercondyloid fossa almost obliterated, (5) intercondyloid eminence relatively low, and (6) a single groove for tendons of *tibialis posticus* and flexor muscles of the foot on internal border of posterior surface of distal end of shaft

The left tibia (fig 46) of this fossil pinniped has about the same proportions as the corresponding bone of the living sea lion *(Eumetopias jubata)*, but differs from the latter in that it was not united with its neighbor, the fibula, at the proximal end This fossil tibia is, nevertheless, slightly shorter than that of an adult *Eumetopias jubata* (No 21537, U S N M)





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48

Left tibia of *Alodesmus kernensis,* No 4304, C A S., × 0 5 Fig 46. External view Fig 47 Proximal view Fig 48 Distal view.

Inasmuch as the condyles of the femur articulate with the proximal expanded extremity of the tibia, condylar facets of corresponding proportions are developed on this surface (fig 47), the external articular facet being somewhat larger than the internal Both condylar facets are more or less flattened in comparison to those on the tibia of *Eumetopias jubata* and the intercondyloid eminence is not as prominent The posterior intercondyloid fossa is much shallower and slightly narrower than in *Eumetopias* Whereas, the anterior intercondyloid fossa is rather broad and deep on the tibia of the recent sea lion, it is almost obliterated on this fossil bone and is limited to a small pit whose area is even less than the rounded intercondyloid eminence The external condyle overhangs the shaft to a greater extent than the internal, a modification correlated with the position of the fibula The roughened surface for the head of the fibula is placed postero-externally on the distal surface of the overhang produced by the lateral expansion of the condylar facet A shallow facet for the patella is present on the anterior face of the proximal end of the tibia, and this surface terminates on each side at the internal margin of the condylar facet

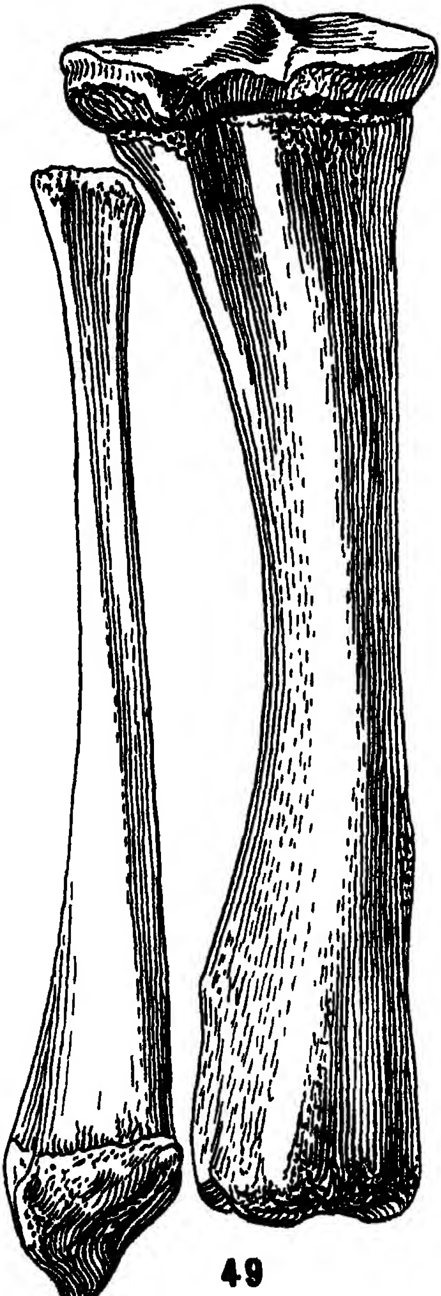
The shaft of the tibia is irregularly three-sided, possessing an anterior, an external, and a posterior surface The expanded extremities of the shaft support the epiphyses which bear the articular facets The longitudinal anterior crest, which defines the limits of the anterior and external surface, is not as distinct as in *Eumetopias jubata*, but the interosseous crest, which separates the external from the posterior surface, is as sharp-edged as in the living animal The shaft itself is bowed forward and inward, and is narrowest near the middle The posterior surface of the shaft is distinctly flattened in comparison to that of *Eumetopias*, there being only a slight indication of the longitudinal depression for the *tibialis posticus* on the proximal third, but there is no trace of an oblique crest such as extends across the distal half of the tibia of the sea lion The interosseous crest terminates about 28 mm above the distal epiphysis, and below this the shaft expands to provide an area for articulation with the distal end of the fibula This fibular articulation facet is limited to the epiphysis of the tibia, and measures 26 mm in width and 10 mm in depth

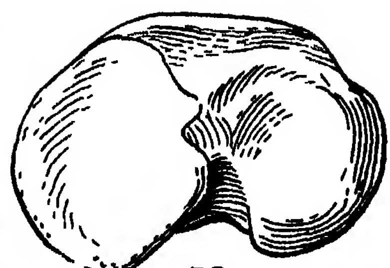
The posterior face of the distal extremity of the tibia of *Eumetopias jubata* displays two deep grooves, of which the mesial or tibial groove is the narrowest The groove on the internal border is quite broad and is bordered by high crests Over these grooves pass the tendons of the *tibialis posticus* and the flexor muscles of the foot On this fossil tibia there is a single broad groove, bordered by low crests, which is placed on the internal border of the posterior face of the distal epiphysis

The distal end of the fossil tibia (fig 48) is furnished with a saddle-like articular surface, which rests upon the trochlea of the astragalus This articular surface is similar in contour to that on the tibia of *Eumetopias*, but the antero-posterior convexity is less pronounced In front of and internal to this articular surface is the usual knob-like malleolus There are, in addition to this specimen, the proximal end of a left tibia (No 4492, C A S), without the epiphysis, of a somewhat smaller individual, and the epiphysis of a right tibia (No 4493, C A S) from an individual about the same size as the one whose tibia is described above

Some idea of the size of a large individual of this fossil pinniped is afforded by the proportions of this tibia (No 4303, C A S) By referring to the measurements given below, it will be seen that this tibia is considerably shorter than that of an old male sea lion *(Eumetopias jubata)* or of a walrus *(Odobenus divergens)* The shaft of the tibia of the walrus forms a sinuate curve, but that of the sea lion is bowed forward This fossil tibia (fig 49), however, has· (1) a shaft with a nearly straight anterior profile, (2) a very limited development of the proximal depression for the *popliteus*, (3) a single groove for tendons of the *tibialis posticus* and flexor muscles of the foot, (4) a narrow posterior intercondyloid fossa, and (5) a pit-like anterior intercondyloid fossa

The shafts of the right (No 4302, C A S) and left (No 4303, C A S) tibia are fractured transversely in two or more places, but are otherwise in a fair state of preservation The epiphyses of these bones are not attached to the shafts A proximal epiphysis for the tibia was included in the collection, but the remaining epiphyses were not found The distal epi-





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49

Left tibia and fibula of *Allodesmus kernensis*, Nos 4303, 4305, C A S, × 0 5 Fig 49 Internal view Fig 50 Proximal view

Measurements of Tibiæ (in millimeters)

	No 4304, C A S Left, *Allodesmus kernensis*	No 4302, C A S Right, *Allodesmus kernensis*	No 4303, C A S Left, *Allodesmus kernensis*	No 7140, U.S.N.M Left, *Eumetopias jubata*	No 21331, U S N M Left, *Odobenus divergens*
Greatest length of tibia	280 6	281 0[1]	296 5[2]	357 0	374 0
Greatest diameter of shaft at distal end	58 6	62.0	61.0	63 0	71 0
Greatest diameter of shaft at proximal end	66 0	73 8	75 0	78 0	98 0
Transverse diameter of shaft at narrowest point	35 2	33 0	33 5	29 5	37 8
Greatest diameter of proximal epiphysis	78 8		91.0	98 5	103 7

[1] Both epiphyses missing [2] Distal epiphysis missing

physis (No 4494, C A S) of another large individual was secured

The proximal epiphysis of this fossil pinniped is very similar to that of the smaller individual (No 4304, C A S) The articular surface of this proximal epiphysis (fig. 50) is furnished with a large external condylar facet and a considerably smaller internal one The external condylar facet is slightly convex and the internal is shallowly concave, and the whole proximal surface is distinctly flattened, paralleling in this respect the head of the walrus tibia The intercondyloid eminence is low, but the posterior intercondyloid fossa is reduced to a narrow re-entrant angle and the anterior intercondyloid fossa is restricted to a small pit-like depression In position and extent, the facet for the patella is similar to that of the smaller individual (No 4304, C A S)

There is a pronounced overhang to the external condyle, notwithstanding the loss of a portion of the external border On the proximal end of the shaft and below the overhanging external condyle is a roughened surface for the head of the fibula

When viewed from the side, attention is at once directed to the expansion of the extremities and to the mesial constriction of the shaft The anterior profile of the shaft is nearly straight

and the external is strongly curved While the shaft is roughly three-sided, the surfaces pass into one another so gradually that the anterior longitudinal crest is not developed and the external interosseous crest is visible only at the distal end The tibia of the walrus is furnished with a well defined longitudinal depression on the proximal half of the posterior face of the shaft for the attachment of the *popliteus* These fossil tibiæ, however, are not similarly modified for this muscle Two short crests below the posterior intercondyloid fossa indicate the position of this muscle

A single groove is present on the internal border of the posterior surface of the distal end of the shaft for the tendons of the *tibialis posticus* and the flexor muscles of the foot

FIBULA

Unfortunately, the head of the left fibula (fig 49) is lost and the distal epiphysis is separated from the shaft In the details of shape and of form the fibula of this fossil pinniped presents some variations from the usual otariid type The shaft is slender and the extremities, especially the distal one, are enlarged It has three lateral surfaces, the anterior, the posterior, and the internal or medial The anterior surface of the shaft of the fibula increases in width from the proximal to the distal end This surface is distinctly flattened and in this respect it is more like the fibula of *Eumetopias* than that of *Odobenus*

There is no trace of an interosseous crest This fossil fibula does agree with those of *Eumetopias* and *Odobenus,* however, in that the external border of the distal end of the shaft is furnished with a short crest, not more than 27 mm in length The posterior surface is convex and is continuous with the medial or internal surface except on the proximal fourth where they are separated by a sharp-edged, longitudinal crest The proximal half of the shaft of the fibula of *Odobenus* is distinctly flattened in a postero-internal direction, and in *Eumetopias* this flattening of the shaft is even more pronounced, but is limited to the proximal fifth The corresponding portion of the shaft of this fossil fibula would appear triangular in cross section

The distal epiphysis is roughly pyramidal in form and is furnished with articular surfaces for the astragalus and the tibia. The articular surface for the lateral side of the astragalus resembles that of the walrus, and its general shape is quite unlike the corresponding facet on the fibula of the sea lion This facet is constricted mesially, and may be described as consisting of a basal articular surface, which extends the full length of the tibial border, and a distal spatulate articular surface with crest-like margins

There is one feature, however, which is quite remarkable and that is the presence of a broad groove bordered by high crests on the posterior face of the distal epiphysis There is an indistinct groove for a similar tendon on the fibula of *Eumetopias*, but it seems to be undeveloped on the fibula of *Odobenus* The facet for articulation with the tibia resembles that on the fibula of the walrus

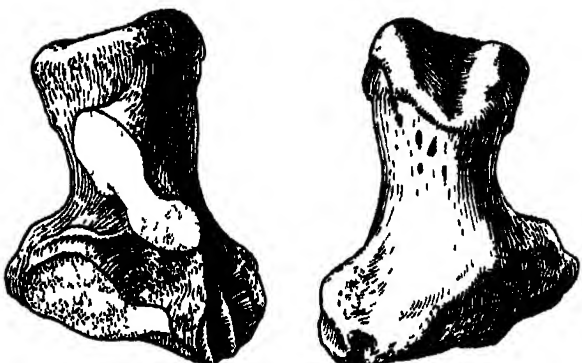
Measurements of Fibulæ (in millimeters)

	No 4305, C A S Left *Allodesmus kernensis*	No 21537, U S N M Left *Eumetopias jubata*	No 21331, U S N M Left, *Odobenus divergens*
Greatest length of fibula	280 5	252 4	367 0
Greatest diameter of shaft at proximal end	30 0	37 4	41 0
Greatest diameter of shaft at distal end	43 8	30 7	54 2
Least postero-internal diameter of shaft	15 8	6 7	14 0

Tarsus

The tarsus of this fossil pinniped is quite similar in many respects to that of the living *Eumetopias jubata* There are, of course, important modifications in the individual tarsal bones The calcaneum, for instance, is characterized by its thicker shaft and more expanded distal extremity, by the curvature and outlines of the sustentacular facet, and by the presence of a broad longitudinal groove on the internal face of

the greater process The astragalus has a short neck and the postero-superior portion of the body is raised above the trochlea It has in addition a distinct facet for the cuboid and a deep pit for the attachment of a tendon on the anterior border of the articular surface for the navicular The navicular does not have a facet for a sesamoid and the facet for the cuboid is rather narrow The cuboid is characterized in part by the shallowness of the groove for the peroneal tendon The entocuneiform, however, resembles that of *Odobenus* in having the proximal facet for the mesocuneiform extended across the fibular face The other tarsal bones are unknown



51 52

Left calcaneum of *Allodesmus kernensis*, No 4309, C A S, × 0 5 Fig 51 Plantar or posterior view Fig 52 Dorsal or anterior view

CALCANEUM

A very strong reason for considering that both sexes are represented among these eight calcaneal bones is the corresponding disparity in size between the bones of male and female otariids The five calcaneal bones (Nos 4309, 4310, 4312, 4313, 4315, C A. S) referred to males of this species may be conveniently grouped according to size, the larger pair probably belonging to an old male and the smaller ones to young males Size alone distinguishes the two larger calcaneal bones (Nos 4309, 4310, C A S) from the three smaller ones All of these tarsals are quite robust and the two

larger ones are exceptionally well preserved. The three smaller calcaneal bones (Nos 4312, 4313, and 4315, C A S) are eroded and broken The two larger calcaneal bones may have belonged to the same individual, inasmuch as they agree in size and appearance The left calcaneum (No 4309, C A S) is the best preserved, and the following description is based largely upon this bone

Aside from its thicker shaft and more expanded distal extremity, the calcaneum (fig 51) of this fossil pinniped bears a close resemblance to the corresponding tarsal of an old male *Eumetopias jubata* As compared with the calcaneum of *Odobenus divergens*, this fossil tarsal is distinguished by the great side-to-side expansion of the distal extremity and by the twisting of the shaft toward the inside of the foot The distal extremity of the calcaneum of *Odobenus* is not disproportionate to the size of the head and the shaft is not noticeably constricted near the middle The calcaneum of *Eumetopias*, however, has the distal extremity expanded in the same direction as in this fossil tarsal On the plantar face of this fossil calcaneum and in the area corresponding to the heel, the distal extremity is provided with a smooth surface, and its proximal extremity is furnished with a broad groove for the accommodation of the tendon of Achilles

The anterior or dorsal surface of the calcaneum (fig 52) is furnished with two large facets for articulation with the astragalus Crossing the calcaneum near the middle is the greater facet on which the ectal facet of the astragalus articulates This facet is constricted mesially and has raised margins Below this facet is the rugose sinuate groove for the interosseous ligament To the inside of this groove is an elongated facet which extends across the internal half of the distal border of the calcaneum and is deeply concave in the direction of its long axis Upon this articular surface rests the sustentacular facet of the astragalus This facet differs in shape and direction from the corresponding facet on the calcaneum of *Eumetopias* and *Odobenus* In case of *Eumetopias*, this facet does not extend laterally to inner margin of the greater process but it does in case of *Odobenus*. No vestige of the broad longitudinal groove which traverses the internal face of the greater process of this fossil calcaneum was found

Measurements of Calcanea (in millimeters)

	No 7140 U S N M Ad ♂ *Eumetopias jubata*	No 4309 C A S ♂—Left, *Allodesmus kernensis*	No 4310 C A S ♂—Right *Allodesmus kernensis*	No 4312, C A S Right, *Allodesmus kernensis*	No 4313, C A S Left *Allodesmus kernensis*	No 21537, U S N M Left *Eumetopias jubata*	No 11589 U S.N M Right *Allodesmus kernensis*	No 11540, U S.N M Right *Allodesmus kernensis*	No. 4314 C A S Right *Allodesmus kernensis*
Greatest antero-posterior diameter of distal end	40 5	41 0	41 0			32 0	28 5	35 8	35 5
Greatest extero-internal diameter of distal end	62 5	72 8				51 5	50 4	58 8	52 +
Greatest proximo-distal diameter of ectal facet	43 8	49 6	49 5	43 5		32 3	34 5	38 5	35 2
Greatest extero-internal diameter of sustentacular facet	41 3	40 0	41 0		34 5	32 9	31 8	32 5	32 5
Greatest transverse diameter of head	45 8	48 7	48 3*		41 0	37 2	31 5	35 5	
Least transverse diameter of shaft	30 8	35 5	36 0	30 0	30 8	22 8	22 5	26 5	30 0
Greatest antero-posterior diameter of cuboid facet	40 0	27 0	26 0			27 7	21 0	22 5	
Greatest length, proximo distally	103 2	97 3	97 0	75 +		81 2	68 0	77 8	73 +

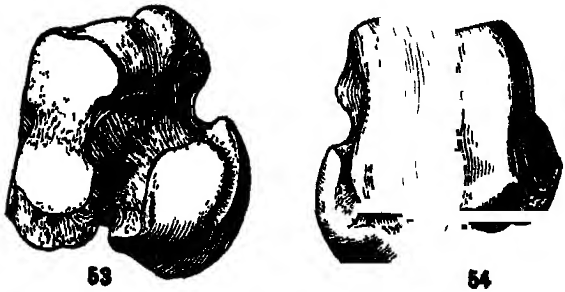
on the calcaneum of either *Eumetopias* or *Odobenus* The peroneal tubercle on the other hand bears a close resemblance to that on the calcaneum of *Eumetopias* The external border of the distal extremity is traversed by a rather broad groove, over which probably passed the ligament for the extensor muscles of the digits

The distal surface of the calcaneum is furnished with a large facet for articulation with the cuboid This facet is shallowly concave, with its transverse diameter approximately equal to its antero-posterior diameter The anterior margin of the facet for the cuboid is co-extensive with the corresponding margin of the facet which articulates with the sustentacular facet of the astragalus, paralleling conditions in the calcaneum of *Eumetopias* and differing in this respect from the calcaneum of *Odobenus* on which these facets are united by a narrow isthmus

The proper allocation of disassociated skeletal elements is often puzzling, and occasionally uncertain, in case of closely related animals The three calcaneal bones (Nos 11589 and 11540, U S N M and 4314, C A S) referred to females are lighter and less robust than those assumed to belong to males of *Allodesmus kernensis*, but are otherwise quite similar As compared with the calcaneum of larger individuals these tarsal bones are distinguished by having a more slender shaft, a narrower peroneal tubercle, and a less robust and more rounded greater process The facets for articulation with other tarsal bones agree in all essential features with those on the calcaneum of larger individuals

Astragalus

Inasmuch as the astragalus is the bone upon which the tibia and fibula rest, it transmits the weight of the body to the foot. The shape and relations of the astragalus with the tibia and fibula in turn indicate the extent to which the hind limbs may be used for progression on land Corollary, and perhaps contributory, to the amount of rotation permissible, is the relative position of the fibular articular surface. The otariid type of astragalus permits the foot to be used for walking, while the phocid type of astragalus in conjunction with certain muscular



53 54

Left astragalus of *Allodesmus kernensis*, No 4308, C A S, × 0 5 Fig 53 Dorsal or anterior view Fig 54 Plantar or posterior view

relations restrict rotation and prevent the foot from being turned forward for progression on land

In many of its essential features, the astragalus of this fossil pinniped agrees with the odobenid type and it is therefore not unlikely that this Miocene animal made use of its hind feet in progression on land The neck is distinctly shorter than in *Eumetopias jubata*, and the extero-lateral process of the body is less twisted The dorsal surface of the body of this fossil astragalus (fig 53) is provided with a saddle-shaped trochlea, as wide in front as behind, for articulation with the distal end of the tibia The lateral borders of the trochlea are rounded and the posterior margin of the latter terminates at the level of the anterior margin of the astragalar foramen The postero-superior border of the body is raised above the trochlea In case of *Odobenus divergens*, the astragalus is furnished with a rather large astragalar foramen, but, in *Eumetopias jubata*, the foramen is rather variable in its occurrence, and, when present, it is vestigial or incomplete The astragalus of *Odobenus* differs from those of *Eumetopias* and this fossil pinniped in another feature, for it is furnished behind the outer half of the trochlea with a deep transverse groove for the *flexor digitorum*, which extends half way across the body and terminates on the posterior border of the external face about mid-way between the upper and lower margins of the lateral facet for the fibula. A very strong tendon would be required to produce a modification of this sort

Over the external face of the body of the astragalus extends a large articular surface, which is convex above and concave below, for the distal end of the fibula Distally, a crest-like margin defines the limits of this articular surface, and, anteriorly, it is continuous with the outer border of the trochlea The distal or extero-lateral process of the body of the astragalus is somewhat everted The internal face of the astragalus is excavated for the attachment of a ligament

On the posterior or plantar surface of the body (fig 53) is an elongated concave ectal facet, which rests upon a corresponding surface on the dorsal or anterior surface of the calcaneum This articular surface resembles a boot in general outline, with the heel at the extero-superior angle of the body and the toe behind the astragalar foramen In length and shape this ectal facet is more like that on the astragalus of *Odobenus* than on that of *Eumetopias* Internal to this ectal articular facet and crossing the bone from the external border of the neck to the inferior opening of the astragalar foramen is a deep furrow for the attachment of the interosseous ligament This furrow also extends upward between the external prolongation of the body and the head, ending in a depression on the lower border of the trochlea This astragalus is thus attached to the calcaneum in the same manner as in the living Odobenidæ and Otariidæ The smaller elliptical sustentacular facet has a slightly convex curvature and its disto-internal margin is separated from the navicular articular surface of the head by a much narrower groove than is present in either *Eumetopias* or *Odobenus*

The astragali of *Odobenus* and of this fossil pinniped each have a broad furrow, continuous mesially with that for the interosseous ligament, which crosses the neck between the sustentacular facet and the medial or internal tubercle On the astragalus of *Eumetopias*, however, the sustentacular facet is not separated from the medial or internal tubercle by a furrow In proportion to the size of the body of the astragalus, the head is smaller than in *Odobenus*, but is not as noticeably flattened antero-posteriorly Curiously enough the astragali of *Eumetopias* and of this fossil pinniped have a deep pit for the attachment of a tendon on the anterior border of the articular surface for the navicular and the resulting indentation of this

Measurements of Astragali (in millimeters)

	No 11541, U S N M Left *Allodesmus kernensis*	No. 4308 C A S Left *Allodesmus kernensis*	No 4307, C A S Left *Allodesmus kernensis*	No 23166 U C Left *Allodesmus kernensis*	No. 4311, C A S Left, *Allodesmus kernensis*	No 4306, C A S. Right, *Allodesmus kernensis*	No 21537, U S N M Left, *Eumetopias jubata*	No 218322, U S N M Left, *Odobenus divergens*	No 7140, U S N M Ad ♂ *Eumetopias jubata*	No 21537 U S N M *Eumetopias jubata*	No 7141, U S N M *Eumetopias jubata*
Greatest vertical diameter	62 6	78 3	64 3	64 2	64 +	71 +	65 2	95 0	80 0	62 8	61 2
Greatest transverse diameter (head to fibular process)	54 0	66 0	56 +[1]	57 5	58 9	63 3	64 0	81 4	73 0	64 9	62 5
Greatest diameter of head	34 0	46 5	36 +	41 0	38 5[1]	42 3	42 6	63 0	51 5	42 7	39 6
Greatest diameter of ectal facet	42 0	50 4	40 8	38 +		45 0	33 5	58 0	42 7	32 5	30 5
Greatest dorso-plantar diameter of body	44 5	56 5	46 3	42 8+		44 9	36 5	62 7	43 7	36 5	33 8

[1]Head incomplete

facet distinguishes these tarsal bones from the astragalus of *Odobenus* The acquisition of additional astragali of this fossil pinniped shows that a previous interpretation of the facets on the head[17] was incorrect, and demonstrates that a distinct facet for the cuboid is present The facet on the postero-internal surface of the head for articulation with the cuboid is large, sub-triangular in outline, and its surface is continuous with the sustentacular and navicular facets

On the whole, the astragalus of this fossil pinniped seems to be characterized by having (1) the articular surfaces of head and trochlea not separated by a rugose interval, (2) an elongated boot-shaped ectal facet; (3) an astragalar foramen which is generally open, (4) a concave trochlea and a raised postero-superior border of the body, (5) a deep groove for the interosseous ligament, (6) the inferior border of sustentacular facet separated from the navicular facet by a narrow groove extending inward from the internal border, and (7) a large subtriangular facet on the head for articulation with the cuboid

The variation in size which exists in these six astragali is strictly comparable to that which distinguishes very old and immature individuals of the recent sea lion *(Eumetopias jubata)*

Navicular

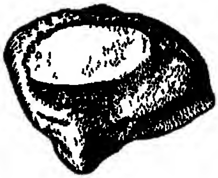
These three fossil naviculars (No 4321, C A S , No 11550, U S N M , No 11551, U S N M) agree with the corresponding tarsals of *Eumetopias jubata* in their general proportions although they vary considerably in size, but they lack the facet for a sesamoid and the articular surface for the cuboid is reduced in extent They are not only less massive than the navicular of *Odobenus divergens*, but differ from the latter in having a narrower facet for the cuboid and a greater dorso-plantar diameter. The dorso-plantar diameter is approximately three-fourths of the transverse tibio-fibular diameter

The large oval articular facet (fig 55) for the astragalus is strongly concave, with a pronounced upward curvature on the tibial and fibular borders The dorsal surface is convex from side to side and is roughened for the attachment of a ligament

[17] R Kellogg, Univ Calif Publ. Bull Dept Geol Sci., vol. 13, no 4, 1922, p 42

The internal angle is rounded and does not appear to have articulated with a sesamoid The navicular of *Eumetopias* has a large facet for a sesamoid on the internal face, but this facet is missing on the navicular of *Odobenus* The external face is

55



56

Left navicular of *Allodesmus kernensis*, No 4321, C A S, × 0 5 Fig 55 Proximal view Fig 56 Distal view

obliquely truncated and is furnished with a short, narrow, articular surface for the cuboid Both *Eumetopias* and *Odobenus* have the navicular furnished with a well defined facet for articulation with the cuboid On the plantar face and nearest to the tibial border is a prominent tuberosity or plantar process The distal surface (fig 56) is furnished with three facets for articulation with the cuneiform bones In relative position, the facets for the cuneiforms are similar to those in *Eumetopias* The largest of these facets rests upon the entocuneiform and extends half way across the bone This

Measurements of Naviculars (in millimeters)

	No 11550, U S N M Left *Allodesmus kernensis*	No 11551, U S N M Left, *Allodesmus kernensis*	No 4321, C A S Left, *Allodesmus kernensis*
Dorso-plantar diameter	33 8	35 4	45 4
Tibio-fibular diameter	47 1	53 5	60 2
Greatest vertical diameter	13 2	19 5	20 7
Greatest transverse diameter of facet for navicular	37 7	40 8	47 0
Greatest transverse diameter of facet for entocuneiform	28 4	32 4	36 0

articular surface is elliptical in outline and is very slightly convex Adjacent to it on the fibular border is a somewhat broader concave facet for the mesocuneiform, and the latter in turn passes imperceptibly into the obliquely placed facet for the ectocuneiform The facets for the cuneiforms do not cover most of the distal surface as in *Odobenus* and the posterior rugose area suggests that in so far as this tarsal is concerned the ligamentary structures were similar to those in the tarsus of *Eumetopias*

Cuboid

Included among the tarsal bones referred to this animal are six cuboids of several sizes, the larger of which are referred to males and the smaller to females Aside from size, the smaller and the larger cuboids differ in the relative development of the groove for the long peroneal tendon The cuboid here figured is smaller than the one described in a previous paper,[18] but,

57 58 59

Left cuboid of *Allodesmus kernensis*, No 4319, C A S., × 0 5 Fig 57 Plantar view Fig 58 Tibial view Fig 59 Dorsal or anterior view

like its mate, is somewhat larger than the four remaining cuboids

There are two facets on the proximal end of the cuboid, the larger of which is strongly convex and supports the calcaneum The smaller facet is concave and articulates with the astragalus and navicular The pyriform facet, which articulates with the ectocuneiform, is placed between the distal margin of the superior facet and the proximal margin of the inferior facets

[18] R Kellogg Univ Calif Publ Dept Geol Sci, vol 13, no 4, 1922, pp 42 44, text figs 17 19

Measurements of Cuboids (in millimeters)

	No 23165 L C Left *Allodesmus kernensis*	No. 4318 C A S Right, *Allodesmus kernensis*	No. 4319 C. A S Left *Allodesmus kernensis*	No 4316, C A S Right *Allodesmus kernensis*	No. 4317 C A S. Left *Allodesmus kernensis*	No. 7140 U S. N M Ad ♂ *Eumetopias jubata*	No. 21537 U S. N M *Eumetopias jubata*
Greatest dorso-plantar diameter at distal end	39 4	39 9	39 6	34 2	36 0	37 2	30 2
Greatest transverse diameter	38 9	33 8	34 7	29 6	33 8	53 2	37 8
Greatest vertical diameter	57 0	53 7	54 5	45 5	47 4	51 5	41 5
Greatest diameter of facet for ectocuneiform	22 0	21 7	21 8	19 0	20 2	17 0	17 0

for the ectocuneiform, and its long axis is oblique to the vertical axis of the cuboid There are two small facets for the ectocuneiform on the distal border and between these facets is a deep groove or indentation for the attachment of some ligament Crossing the cuboid (fig 57) in an oblique direction below the tuberosity on the plantar face is the groove for the long peroneal tendon This groove is deeper and more sharply defined on the larger than on the smaller cuboids, but is not as well developed as on the cuboid of *Eumetopias*

On the distal face, the articular surfaces for the fourth and fifth metatarsals are separated by a sharp crest These facets correspond in all essential details with those on the cuboid of *Eumetopias jubata*

Entocuneiform

The meso- and ecto-cuneiforms are not represented in this collection There are, however, two entocuneiforms from the left side and two from the right The facets on the entocuneiform and the navicular for articulation with the mesocuneiform show that the latter must have resembled the corresponding tarsal of *Odobenus* An examination of the pes of the sea lion and the walrus will show that there are some well marked differences in the manner in which these wedgelike bones articulate with one another, and in this connection it is interesting to note that the entocuneiform (fig 60) of this fossil pinniped is distinguished from the corresponding tarsal of *Eumetopias* by the same characters which ally it with *Odobenus* As seen from in front these fossil entocuneiforms correspond in shape to those of *Odobenus divergens,* but dif-

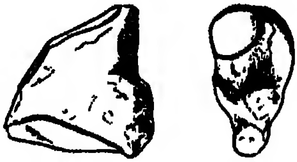
60 61

Left entocuneiform of *Allodesmus kernensis,* No 4322, C A S, × 0 5
Fig 60 Dorsal or anterior view Fig 61. Internal view

Measurements for Entocuneiformes (in millimeters)

	No. 4322 C. A. S. Left, *Allodesmus kernensis*	No. 4323 C. A. S. Left *Allodesmus kernensis*	No. 4324, C. A. S. Right, *Allodesmus kernensis*	No. 11546, U. S. N. M. Right, *Allodesmus kernensis*	No. 1745 U. S. N. M. Left, *Odobenus divergens*	No. 7140 U. S. N. M. Ad. ♂, *Eumetopias jubata*	No. 7141, U. S. N. M. *Eumetopias jubata*
Greatest proximo distal diameter	48 3	46 9	47 5	40 8	42 4	48 4	34 6
Greatest tibio-fibular diameter	50 6	47 3	47 8	38 +	50 5	44 8	33 3
Greatest dorso-plantar diameter	29 8	27 5+	26 1	22 1	29 3	32 8	23 3
Greatest diameter of facet for navicular	30 8	31 4	32 0	26 2	23 7	44 6	34 2
Greatest diameter of facet for first metatarsal	42 4	40 8	41 0	32 0	48 7	39 4	32 8
Greatest diameter of facet for mesocuneiform	21 2	16 5	17 0	15 +	24 8		
Greatest diameter of facet for sesamoid	22 4	17 1	15 7	15 5	13 4	24 0	17 0

fer in that the slope of the proximal facet is more oblique and that of the distal facet is less oblique The proximal concave articular surface for the mesocuneiform extends across the fibular face below the facet for the navicular and terminates at the proximo-plantar angle This detail seems to characterize the entocuneiforms of *Odobenus*, *Pontolis* cf *magnus*,[19] and this fossil pinniped



62 63

Right entocuneiform of *Allodesmus kernensis*, No 11546, U S N M, × 0 5 Fig 62 Dorsal or anterior view Fig 63 Internal view

The proximal end of the tibial or internal face (fig 61) is furnished with a large oval-shaped facet for a sesamoid Behind this facet the internal surface curves toward the plantar face A club-shaped and saddle-like articular surface for the first metatarsal occupies the distal end of this tarsal bone The facet on the proximal end for articulation with the navicular is more or less elliptical in outline and is shallowly concave The dorsal surface is depressed and pitted as in *Odobenus*, but the plantar surface is more irregular and is furnished with a broad deep groove which terminates at the disto-internal angle The plantar face of this fossil entocuneiform bears a closer resemblance to the corresponding tarsal of *Eumetopias jubata* than to that of *Odobenus divergens*

Metatarsals

The fifth metatarsal is represented by four bones of different sizes, ranging from medium to large, and all belonging to a right pes They exhibit a surprising resemblance to the corresponding metatarsal bone of *Eumetopias jubata* The size, shape, and extent of the facets on the proximal end are essen-

[19] R Kellogg Publ 348, Carnegie Inst Washington, 1925, pp 107 108, text figs 13 14

tially the same in both pinnipeds, but the fossil bones have a relatively wider, flattened shaft As compared with the fifth metatarsal of *Eumetopias*, the curvature of the proximal facet for the fourth metatarsal is much less concave, the facet for articulation with the cuboid has a much lower heel, and the enlarged proximo-plantar angle forms a rounded, inwardly directed protuberance

Fourth metatarsal bones from the right and left pes likewise agree in essential details with corresponding bones of *Eumetopias jubata* The proximal end of the shaft is somewhat deeper and there is no constriction between the anterior and proximal facets for articulation with the fifth metatarsal The shape of the proximal end of this metatarsal is similar to that of *Eumetopias*, but the articular surface is more convex and is continuous internally with facets for the head of the third metatarsal

A single third left metatarsal is included in the collection and although the general contour of the proximal end is similar to that of the same bone in *Eumetopias jubata*, it differs from the living sea lion in having an anterior, circular, concave facet and a relatively small posterior facet for articulation with the fourth metatarsal The internal surfaces for articulation with the second metatarsal agree very closely with that of *Eumetopias*

Second metatarsal bones of at least three individuals are included in this lot of bones, three of which are from a right pes and a like number from a left pes The anterior and posterior facets on the proximal end for articulation with the third metatarsal are separated by a rather deep groove There is nothing to indicate that the second metatarsal articulated with the entocuneiform as in *Eumetopias* The second metatarsal of *Eumetopias* has a large convex oval facet for articulation with a corresponding articular surface on the entocuneiform These fossil metatarsals have anterior and posterior facets separated by a broad groove on the internal face of the head, but there is no indication of a corresponding surface on the entocuneiform There is also a large, oval, concave surface below the posterior facet on the internal surface of the proximal end of the shaft It would appear that these

facets articulated with the first metatarsal which is not represented in this collection

Measurements of Metatarsals (in millimeters)

	II C A S. No 4453	III C A S No 4450	IV C. A. S No 4448	V C. A. S No 4446	V U.S N M No 11861
Greatest length	89 0	87 +	98 0	93 +	
Dorso-plantar diameter of head	30 4	35 +	41 5	41 +	46 0
Transverse diameter of head	16 7	21 0	21 8	25 8	27 5
Narrowest transverse diameter of shaft	12 5	16 9	15 7	14 8	16 8
Transverse diameter of distal end	22 0		22 8		

7 **Neotherium mirum**[20] Kellogg, new genus and species

Type material Right calcaneum, No 11542, U S N M , right astragalus, No 11543, U. S N M , right cuboid, No 11552, U S N M ; left navicular, No 11548, U S N M

Referred specimens Right femur, No. 4300, C A S , left femur, No 4549, C. A S , right humerus, No 4548, C A S., third metatarsal, No 4464, C A S , phalanges, Nos 4573, 4574, C A S.; all from **Sharktooth Hill, Kern County, California**; Temblor; Miocene, Charles Morrice, Coll , 1924.

Careful study of the pinniped material collected by Mr Morrice has led the writer to conclude that at least two distinct types of otariids are present in the middle Miocene, Temblor fauna This conclusion is based largely upon the structural peculiarities of the tarsal bones The characters of the tarsal bones are quite constant in living pinnipeds and afford a means for identifying skeletal material. The differences observed between these bones and those referred to *Allodesmus kernensis* seem of generic value Judging from the proportions of the skeletal elements that are known, this fossil pinniped was no larger and probably smaller than a female *Zalophus californianus*

[20] νέω, to swim, θηρίον, wild beast.

HUMERUS

The fragment of the right humerus (No 4548, C A S) referred to this pinniped consists of the proximal half of the shaft, but the epiphysis, head, and portions of the deltoid crest are missing The shaft is narrowed near the middle, arcuate in outline internally, and exhibits a very slight external curvature The deltoid crest is quite thin and the anterior border does not fold over the external face of the crest as in *Zalophus*

FEMUR

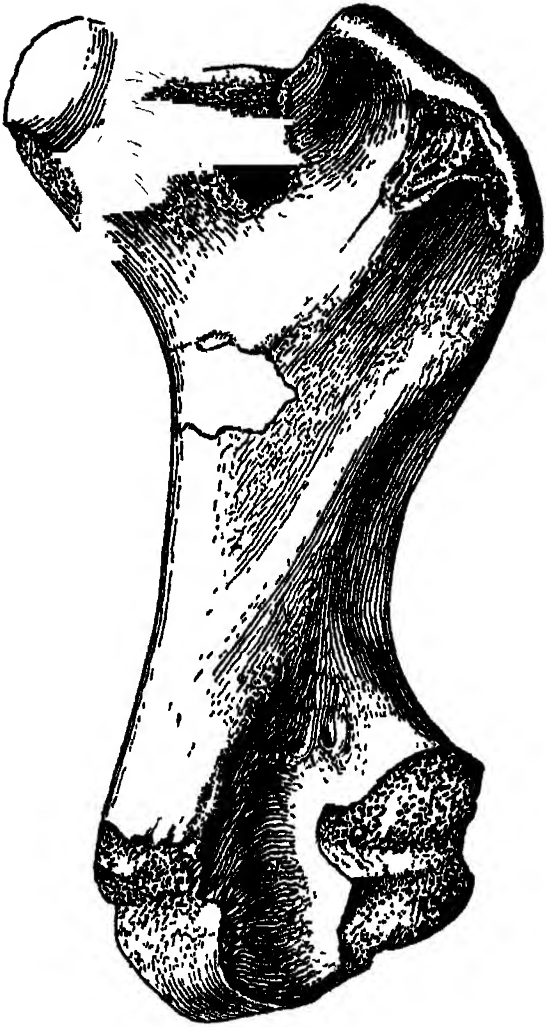
It is unfortunate that the right femur (No 4300, C A. S) referred to this pinniped is badly damaged The extremities are eroded, the shaft is fractured, and both condyles are missing A fragment of the distal extremity of a left femur (No 4549, C A S) of about the same size furnishes some additional information concerning the external condyle and the patellar surface The shaft of the femur (fig 64) is rather slender, resembling that of *Zalophus californicus,* but it is fractured traversely at the level of the lesser trochanter, and a section of bone in the region of the latter is missing The curvature of the broken edges in this region indicates that the lesser trochanter was present The greater trochanter is large and broad, and the intertrochanteric crest is not developed The trochanteric fossa is large and quite deep, as is that of *Allodesmus,* whereas in *Zalophus* the fossa is almost obliterated It is obvious that the neck is rather long as compared with that of *Zalophus,* but most of the head is missing The intercondyloid fossa is much longer than on the femur of *Zalophus,* but the patellar surface is quite similar

This fossil femur differs from those of *Zalophus* and *Eumetopias* in (1) the markedly greater transverse diameter of the proximal extremity, (2) the longer neck, and (3) the deeper trochanteric fossa

Measurements of the Femur

Greatest length of shaft as preserved	136.5 mm
Greatest transverse diameter of proximal end (head to greater trochanter)	73 + mm.
Least transverse breadth of shaft	31.8 mm.

January 30, 1931

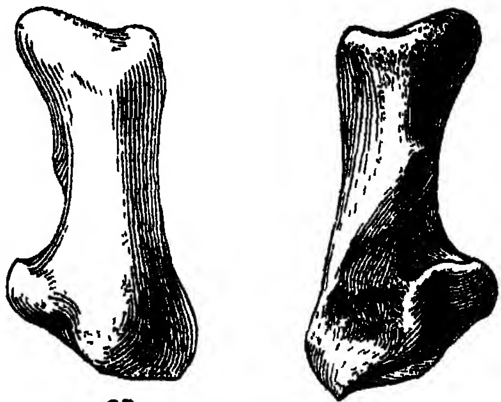


64

Fig. 64. Posterior view of right femur of *Neotherium mirum*, No. 4300, C. A. S., × 1.0.

CALCANEUM

In its general features this right calcaneum (No 11542, U S N M) is somewhat similar to those of *Arctocephalus australis* (No 21735, U S N M) and *Zalophus californianus* (No 23332, U S N M) It differs from both, however, in having a more slender shaft, no groove on internal angle of proximal end of shaft, less expanded distal extremity, and no



65 66

Right calcaneum of *Neotherium mirum*, No 11542, U S N M, × 1 0 Fig 65 Plantar or posterior view Fig 66 Dorsal or anterior view.

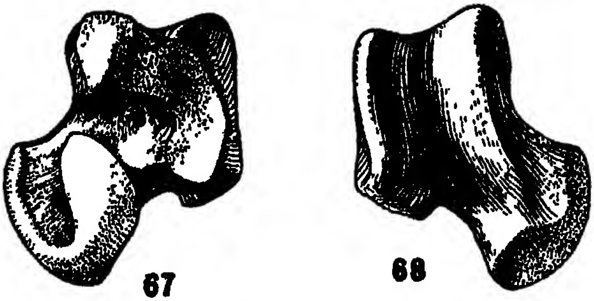
shelf below the sustentacular facet The ectal facet (fig 66) is narrow, curved from end to end, and distinctly raised above the shaft The groove for the interosseous ligament is not sharply defined, but it is quite rugose The sustentacular facet covers the dorsal face of the greater or internal process The peroneal tubercle appears to be eroded and the question arises as to whether or not it was traversed by a vertical groove as in *Arctocephalus* or flattened as in *Zalophus* The concave distal facet for the cuboid is rather small, but occupies most of the distal face of the shaft

Measurements of the Calcaneum

Greatest length of shaft	528 mm
Greatest dorso-plantar diameter of distal end	16.8 mm
Greatest tibio-fibular diameter of distal end .	282 mm
Greatest diameter of ectal facet	210 mm

ASTRAGALUS

This right astragalus (No. 11543, U S N. M) differs from the corresponding tarsal of *Arctocephalus australis* and *Zalophus californianus* in having: (1) a deeper and more saddle-shaped trochlea, (2) a much shorter and less everted external prolongation of the body and consequently a less concave curvature of the fibular facet, (3) postero-superior portion of the body prolonged backward and raised above transverse groove between it and trochlea, (4) a relatively shorter neck, (5) a more convex distal facet for navicular, (6) a narrow crescentic ectal facet, and (7) a shallower groove for interosseous ligament



67 68

Right astragalus of *Neotherium mirum*, No 11543, U S N M, × 1 0 Fig 67 Plantar or posterior view. Fig 68 Dorsal or anterior view

The lateral borders of the trochlea (fig 68) are rounded and its posterior limits are sharply defined Although the astragalar foramen is closed, its former position is marked by an irregular depression with numerous minute vascular foramina The flattened fibular facet is somewhat longer than in either *Arctocephalus* or *Zalophus* The crescentic ectal facet (fig 67) is strongly concave and its lower edge is raised above the shallow groove for the interosseous ligament In the middle of this groove is the closed plantar orifice of the astragalar foramen The sustentacular facet is slightly convex and its distal margin is cut off from the navicular facet by a shallow tongue-like groove

Measurements of the Astragalus

Greatest vertical diameter	39 0 mm
Greatest transverse diameter	32 0 mm.
Greatest diameter of head	22.2 mm
Greatest diameter of ectal facet	21.8 mm
Greatest dorso-plantar diameter of body	26.6 mm

NAVICULAR

The small left navicular (No. 11548, U S N M) is rather long, relatively narrow, and quite thin Differences in relative depth and in curvature of the articular surface for the astragalus distinguish this tarsal from those of *Arctocephalus australis* and *Zalophus californianus* A rather prominent tuberosity directed toward the fibular side arises from the plantar face The elliptical facet for the astragalus (fig 69) is strongly concave in all directions This navicular lacks a distinct facet for articulation with the cuboid The facets on the distal face (fig 70) for the three cuneiforms correspond with those on the navicular of *Arctocephalus australis* The larger one of these facets rests upon the entocuneiform and is separated from the smaller medial facet for the mesocuneiform by a raised ridge, and the latter in turn merges with the

69

70

Left navicular of *Neotherium mirum*, No 11548, U S N M, × 1 0
Fig 69 Proximal view Fig 70 Distal view

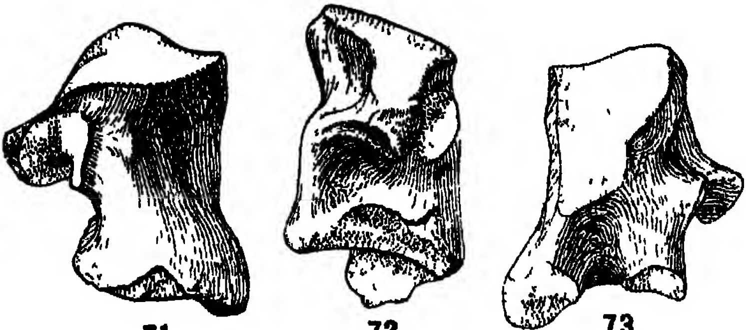
obliquely placed facet for the ectocuneiform Between the plantar tuberosity and the above mentioned facets is a roughened area for the interosseous ligament

Measurements of the Navicular

Dorso-plantar diameter	18 9 mm
Tibio-fibular diameter	24 6 mm
Greatest vertical diameter	11 2 mm

Cuboid

The right cuboid (No 11552, U S N M) is relatively large and its configuration is more like that of *Pontolis* cf *magnus*[21] than that of any living otariid On the proximal end of the cuboid is a large articular facet, curving obliquely forward and outward from the interno-plantar angle, which supports the calcaneum The extero-plantar angle of this facet



71 72 73

Right cuboid of *Neotherium mirum*, No 11552, U S N M, × 1 0 Fig 71 Dorsal or anterior view Fig 72 Plantar or posterior view Fig 73 Tibial view

is extended over upon the base of the prominent plantar tuberosity This facet is continuous internally with the sub-vertical concave facet for the astragalus The postero-external tuberosity is greatly produced and its distal face is traversed by the sharply defined broad groove for the *peroneus longus* A ridge-like internal continuation of this tuberosity (fig 72) extends across the plantar face, but it diminishes rapidly in height

On the internal or tibial face (fig 73) is a large proximal articular surface for the astragalus, navicular, and ectocuneiform Two small facets for the ectocuneiform separated by a deep notch are likewise present on the distal border of the internal face

Distally there is a curved articular surface for the proximal ends of the fourth and fifth metatarsals, the facet for the fifth metatarsal being situated on the extero-plantar angle

[21] R Kellogg. Structure of the flipper of a Pliocene pinniped from San Diego County, California Publ. 348, Carnegie Inst. Washington, 1925, pp 106-107, fig 12

Measurements of the Cuboid

Greatest proximo-distal diameter.	34.3 mm.
Greatest median dorso-plantar diameter.	25.4 mm.
Greatest tibio-fibular diameter	23.3 mm.

METATARSAL

The proximal end of a third right metatarsal (No 4464, C A S) is referred to this pinniped It has a rather narrow facet for articulation with the ectocuneiform On the extero-anterior angle of the head is a circular concave facet for articulation with the fourth metatarsal The shaft is deeply excavated between the outwardly turned posterior angle of the head and the above described facet There is a prominent convex articular surface for the second metatarsal on the anterior angle of the head The shaft is rather slender and almost cylindrical below the head

PHALANGES

Two slender phalanges (Nos 4573 4574, C A S) are thought to belong to this pinniped The metatarsal and these two phalanges are similar in their proportions to the corresponding bones of *Callorhinus alascanus* The shorter of these two phalanges has an expanded distal extremity and may have been the middle phalanx of the first digit, while the other one tapers from the base to the extremity and corresponds in its proportions to the proximal phalanx of the fifth digit One measures 50 mm and the other 41 mm in length

Order CETACEA

Three species of cetotheres, a sperm whale, a shark-toothed porpoise, and nine other species of porpoises are recognized in the cetacean remains from the Temblor formation This is the largest fauna of cetaceans thus far known for any formation on the Pacific Coast of North America One incomplete skull and the fragments of another skull show the stage of telescoping present in one of the cetotheres Fragments of the cranium in addition to the ear bones indicate the presence of a second species The third cetothere is known only from a single periotic bone. Other skeletal elements belonging to

cetotheres are included in the collection There are a number of incomplete bullæ, in most cases the involucrum alone, which are not referred to any particular cetothere Some of the limb bones are referred tentatively to these cetotheres, but no attempt has been made to allocate the incomplete and eroded vertebræ which unquestionably belong to one or another of these archaic whalebone whales

It is recognized that adequate material is not available to settle the relationships of many of the porpoises It is sufficient, however, to indicate the presence of a number of distinct species The sperm whale is fairly well represented by skeletal elements, for we have the skull of an adult, portions of the skull of a young individual, and a number of ear bones The new species of porpoises hereinafter described are based solely upon the periotics, since the writer has found that these ear bones are quite diagnostic Mention is made of other skeletal elements belonging to odontocetes, and some of these bones are figured and described, although in most instances they are not referred to any particular porpoise They are described merely as a matter of record and it is hoped that future collecting will provide the material for an adequate discussion of the characters of the several species of porpoises represented in the Temblor fauna

Suborder Mysticeti

Family CETOTHERIIDÆ Cetotheres

At least three different kinds of cetotheres are included among the cetacean bones collected by Mr Morrice at Sharktooth Hill A considerable portion of the skull, with the ear bones of the right side attached to it, forms the basis for one of these species; fragments of the hinder portion of the skull and the right periotic represent a second species, and an imperfect left periotic bone indicates the presence of a third species. Complete, as well as fragmentary cetothere limb bones of various sizes were sorted out of this collection The bones of many kinds of fossil pelagic mammals were found scattered about in this bone bed, and it is unfortunate that none of the skeletal elements of the cetotheres were associated with skulls Hence the allocation of these limb bones to any

one of the above mentioned cetotheres may appear more or less arbitrary, but nevertheless they were critically compared with the corresponding bones of cetotheres found elsewhere and it is believed that the present disposition is as nearly accurate as one can hope to accomplish by using comparative measurements and other available data Vertebræ of several sizes, and from different parts of the column, which undoubtedly belong to cetotheres, were also obtained by Mr Morrice After some study it was decided to omit any discussion of these vertebræ because of the difficulty of allocating these bones with any degree of certainty to any particular species Not one of the atlases fitted the condyles of the cetotheres hereinafter described Vertebræ, especially those from the cervical and caudal regions, of fossil porpoises exhibit a considerable range of variation, and it is not unlikely that those of the larger whales are equally, if not more, variable The criteria employed for the classification of the mysticetes depend upon the relations of the bones which comprise the skull and before entering into a detailed discussion of these Temblor cetotheres it is desirable to summarize the diagnostic characters of the families Cetotheriidæ and Balænopteridæ

Miller's opinions[32] in regard to the diagnostic characters of the families Cetotheriidæ and Balænopteridæ are in so close accord with my own that they are repeated to clarify the discussion of the various genera, which are referred to these families

In both families the telescoping of skull is accomplished by a combined forward movement of posterior elements and a backward movement of anterior elements, which at least produces some interdigitation of rostral and cranial elements The nasals and ascending processes of premaxillaries are not situated entirely anterior to the level of the orbital wings of the frontals, and a definite ascending process of the maxillary is always present.

In the Cetotheriidæ the parietal is entirely behind the posterior level attained by nasals and ascending processes of maxillaries and premaxillaries, the occipital shield does not extend forward over level of orbit, or beyond anterior level attained by articular portion of squamosal, the frontal is

[32] G S Miller, Jr, Smithson Misc. Coll, vol 76, publ 2710, 1923, pp 21 22

broadly exposed on interorbital region; the expanded lateral (articular) portion of squamosal is relatively small, and its under surface is not deeply concave The supraorbital process of frontal slopes gradually downward and outward from the level of the dorsal surface of interorbital region, the parietals come in contact, or nearly so, on the vertex between the occipital shield and the frontal, the nasals are small (normal), their combined dorsal area equaling much less than half that of supraorbital portion of frontal, the rostrum tends toward breadth rather than depth, the mandible is slender and conspicuously bowed outward

In the Balænopteridæ the parietal extends forward laterally beyond posterior level attained by nasals and ascending processes of maxillaries and premaxillaries, the occipital shield extends forward over level of orbit and beyond the anterior level attained by the articular portion of squamosal, the frontal is scarcely or not exposed on interorbital region, the expanded lateral (articular) portion of squamosal is relatively large, its under surface being deeply concave, the supraorbital process of frontal is abruptly depressed at base to a level noticeably below that of dorsal surface of interorbital region, the rostrum tends toward breadth rather than depth, the mandible is conspicuously bowed outward

In view of the present confusion prevailing in the application of generic names to fossil whalebone whales, it seemed desirable to fix the genotypes of those that include several species In each instance, where it was necessary to fix the genotype from several species listed by the author when the generic name was proposed, a species founded upon a skull was chosen, if possible

Genotypes of Genera of Fossil Whalebone Whales Belonging to the Families Cetotheriidæ and Balænopteridæ

Middle Oligocene

Pachycetus, Van Beneden, Bull Acad Roy Sci Belgique, (3), vol 6, No 7, 1883, pp 31-32. [Genotype, here designated as *Pachycetus robustus*, Van Beneden, 1883, Rupelian stage, "dans le couches phosphatées très connues de Helmstedt (Bas Brunswick) — entre l'Elbe et le Weser — un sable vert glauconifère", Museum fur Mineralogie, Geologie und Vorgeschichte, Dresden, Germany]

UPPER OLIGOCENE

Cetotheriopsis, Brandt, Bull Acad Imp Sci St Petersbourg, vol. 16, 1871, p 566 [Genotype, *Balænodon lintianus*, Meyer, 1849, Aquitanian or I Mediterranean stage, white marine sands in the vicinity of Linz, Austria. *Stenodon*, Van Beneden, 1865 (preoccupied), and *Aulocetus*, Van Beneden, 1875, have the same genotype as *Cetotheriopsis*, Museum Francisco-Carolinum, Linz, Upper Austria]

LOWER MIOCENE

Palæobalæna, Moreno, Rev Mus La Plata, vol 3, 1892, p 394 [Genotype, *Palæobalæna bergi*, Moreno, 1892, Langhian Stage, Santa Cruz beds at Misioneros, Patagonia, Argentine Republic, Museum at La Plata]

UPPER MIOCENE

Cephalotropis, Cope, Science, n s, vol 3, 1896, p 880, *idem*, Proc Amer Philos Soc, vol 35, no 151, 1896, pp 141, 143-145 [Genotype, *Cephalotropis coronatus*, Cope, 1896, Yorktown formation (= St Marys), probably from Chesapeake region, eastern United States, United States National Museum]

Cetotheriomorphus, Brandt, Mem Acad Imp Sci St Petersbourg (7), vol 20, no 1, 1873, pp. ii, 161-162, pl 23, figs 4-8 [Genotype, *Cetotheriomorphus dubius*, Brandt, 1873, locality unknown, possibly southern Russia, Museum of the Imperial Institute of Mines, St. Petersbourg]

Cetotherium, Brandt, L'Institut, Paris, vol 11, no 499, 1843, p 241, and no 502, p 270 [Genotype, *Cetotherium rathkii*, Brandt, 1843, Sarmatian stage, Steppe limestone, Kertsch near promontory Takali, southern Russia, Museum of the Imperial Academy of Sciences, St Petersbourg]

Eucetotherium, Brandt, Mem Acad Imp Sci de St Petersbourg (7), vol 20, no 1, 1873, p 143 [Genotype, here designated as *Cetotherium helmersenii*, Brandt, 1873, *op cit*, p 95, pl 6, Sarmatian stage, limestone, near the promontory Pekla on the coast of the Black Sea, Crimea, Russia, Museum of Imperial Institute of Mines, St Petersbourg]

Herpetocetus, Van Beneden, Bull Acad Roy Sci Belgique, (2), vol 34, no 7, 1872, p 247 [Genotype, *Herpetocetus scaldiensis*, Van Beneden, 1872, Bolderien stage, sables inferieurs d'Anvers, du nouveau canal d'Herenthals, troisieme section, partie de Stuyvenberg, environs of Antwerp, Belgium, Musée Royal d'Histoire Naturelle de Belgique, Bruxelles]

Isocetus, Van Beneden, Bull Acad Roy Sci Belgique, (2), vol. 50, 1880, pp 24-25 [Genotype, *Isocetus De Pauwii*, Van Beneden, 1880, Bolderien stage, sables, environs of Antwerp, Belgium, Musee Royal d'Histoire Naturelle de Belgique, Bruxelles]

Mesocetus, Van Beneden, Bull. Acad. Roy. Sci. Belgique, (2), vol. 50, no 7, 1880, pp 22-23 [Genotype, *Mesocetus longirostris*, Van Beneden, 1880, Bolderien stage, sables; environs of Antwerp, Belgium, Musée Royal d'Histoire Naturelle de Belgique, Bruxelles.]

Mesoteras, Cope, Amer Nat. vol. 4, 1870, p 128 [Genotype, *Mesoteras kerrianus*, Cope, 1870, (?) Yorktown formation, marl, Quanky Creek, Roanoke River, Halifax County, North Carolina (possibly near town of Halifax, about 30 miles south of northern boundary of North Carolina, and south of towns of Roanoke Falls & Weldon); United States National Museum and the State Museum, Raleigh, North Carolina.]

Metopocetus, Cope, Proc. Amer Philos Soc., vol. 35, no 151, 1896, p 141 [Genotype, *Metopocetus durinasus*, Cope, 1896, Calvert formation, marl near the mouth of the Potomac River, Maryland, United States National Museum]

Pachyacanthus, Brandt, Bull. Acad Imp Sci. St. Petersbourg, vol 16, 1871, pp 564-565, and *idem*, Mem. Acad. Imp Sci St. Petersbourg (7), vol. 20, no 1, 1873, pp. 166-169, pls. 14-17 [Genotype, here designated as, *Pachyacanthus suessii*, Brandt, 1871, Sarmatian stage, Tegel von Nussdorf, Vienna basin, Austria, Naturhistorischen Staatsmuseum, Wien, Austria]

Parietobalæna, Kellogg, Proc U S Nat. Mus, vol 63, publ 2483, 1924, p 1 [Genotype, *Parietobalæna palmeri*, Kellogg, 1924, Calvert formation, greenish sandy clay, 1 mile north Dare's wharf, Calvert County, Maryland, United States National Museum]

Rhegnopsis, Cope, Proc. Amer Philos Soc, vol 35, no 151, 1896, p 145 [Genotype, *Balæna palæatlantica*, Leidy, 1851; St. Marys formation; City Point, Prince George County, Virginia. *Protobalæna*, Leidy, 1869 (preoccupied), has the same genotype; Academy of Natural Sciences of Philadelphia]

Siphonocetus, Cope, Proc Amer Philos Soc, vol 34, no 147, 1895, pp 140-141, pl 6, figs 3-5 [Genotype, *Balæna prisca*, Leidy, 1851, St Marys formation, Westmoreland County, Virginia, Academy of Natural Sciences of Philadelphia.]

Tretulias, Cope, Proc Amer Philos Soc., vol 34, no. 147, 1895, pp 143-145, pl 6, fig 2. [Genotype, *Tretulias buccatus*, Cope, 1895, "Yorktown", possibly Maryland or Virginia, United States National Museum]

Ulias, Cope, Proc Amer. Philos Soc, vol 34, no 147, 1895, pp 141-143, pl 6, fig 1 [Genotype, *Ulias moratus*, Cope, 1895, "Yorktown", possibly Maryland or Virginia, United States National Museum]

LOWER PLIOCENE

Amphicetus, Van Beneden, Bull. Acad Roy Sci. Belgique, (2), vol 50, no. 7, 1880, pp 20-21 [Genotype, here designated as, *Amphicetus later*, Van Beneden, 1880, Diestien stage, sables, environs of Antwerp, Belgium, Musée Royal d'Histoire Naturelle de Belgique, Bruxelles]

Cetotheriophanes, Brandt, Mem. Acad Imp Sci. de St Petersbourg (7), vol. 20, no 1, 1873, pp 148-149, 156-157, pl 20, figs. 13-16 [Genotype, here designated as, *Cetotherium (Cetotheriophanes) cuvieri*, Brandt, 1873 = *Balæna cuvieri*, Fischer, 1829, Synopsis Mammalium, p 527; Plaisancian stage, marna argillosa cerulea, Monte Pulgnasco, Italy, Museo civico di Milano, Italy]

Heterocetus, Van Beneden, Bull Acad Roy Sci Belgique (2), vol 50, no. 7, 1880, pp. 21-22. [Genotype, here designated as, *Cetotherium brevifrons*, Van Beneden, 1872; Diestien stage, sables moyens d'Anvers, Belgium, Musée Royal d'Histoire Naturelle de Belgique, Bruxelles.]

Megapteropsis, Van Beneden, Bull Acad Roy Sci. Belgique, (2), vol 34, no 7, 1872, p 242. [Genotype, *Megapteropsis robusta*, Van Beneden, 1872, Diestien stage, sables moyens d'Anvers, Eeckeren and Wyneghem, near Antwerp, Belgium, Musee Royal d'Histoire Naturelle de Belgique, Bruxelles.]

Notiocetus, Ameghino, Revista Argentina Hist Nat, vol 1, entrega 3a, 1891, p 167, fig 75 [Genotype, *Notiocetus romerianus*, Ameghino, 1891, Pontian, Pampean formation, Bahia Blanca, Argentine Republic]

Plesiocetopsis, Brandt, Mem Acad Imp Sci St Petersbourg (7), vol 20, no 1, 1873, pp 143-146 [Genotype, here designated as, *Plesiocetus hupschii*, Van Beneden, 1859, Diestien stage, sables, Saint Nicolas, environs of Antwerp, Belgium; Musée de l'Université Catholique, Louvain]

Plesiocetus, Van Beneden, Bull Acad Roy Sci Belgique, (2), vol 8, no. 11, 1859, p. 139 [Genotype fixed as, *Plesiocetus garopii* by Van Beneden, 1872, Bull. Acad. Roy Sci Belgique (2), vol 34, p 242, Diestien stage, sables, Saint Nicolas, environs of Antwerp, Belgium, Musée de l'Université Catholique, Louvain]

MIDDLE PLIOCENE

Burtinopsis, Van Beneden, Bull. Acad Roy. Sci Belgique, (2), vol. 34, no 7, 1872, p 246. [Genotype, *Burtinopsis similis*, Van Beneden, 1872; Scaldisien stage; sables, environs of Antwerp, Belgium, Musée Royal d'Histoire Naturelle de Belgique, Bruxelles]

Idiocetus, Capellini, Atti R. Accad dei Lincei, Roma (2), vol 3, pt. 2, 1876, pp 12-13, *idem*, Mem. R. Accad Sci Bologna, (6) vol. 2, 1905, pp 71-80, pls 1-2. [Genotype, *Idiocetus guicciardinii*, Capellini, 1876, Astian stage; argilla turchina, Montopoli nel Valdarno inferiore, Tuscany, Italy; Museo di Geologia e di Paleontologia, Firenze, Italy]

UPPER PLIOCENE

Palæocetus, Seeley Geol. Mag, London, vol. 2, no 8, 1865, pp 54-57, pl 3 [Genotype, *Palæocetus sedgwickii*, Seeley, 1865, (?) Red Crag, Roswell Pit, in boulder clay of Ely, near Cambridge, England (See Lydekker, Cat. Foss Mamm Brit Mus, pt 5, 1887, p 31)]

Something like 15 generic names have been proposed for fossil cetotheres from the upper Miocene, whereas but one species of lower Miocene age has been honored with a distinct generic name. Turning to the Pliocene we find that the two families, Cetotheriidæ and Balænopteridæ, are represented by seven genera in the lower Pliocene, one in the middle Pliocene, and two in the upper Pliocene, excepting of course those genera which have living representatives.

The skull of the upper Oligocene *Cetotheriopsis*[23] is characterized in part by a high, narrow supraoccipital shield curving more forward than upward and divided mesially by a long vertical carina, elongate zygomatic processes not reaching forward to the level of the apex of the supraoccipital shield, and the vertex of the braincase, viewed from behind, being strongly depressed below the arching lambdoid crests.

Of the 15 upper Miocene genera, the genotypes of six (*Herpetocetus, Isocetus, Rhegnopsis, Siphonocetus, Tretulias,* and *Ulias*) were based wholly or in part upon mandibles, the remainder of the skulls being unknown. Critical comments on the validity of those that were founded on mandibles are given by Winge[24] and True[25]. Vertebræ constitute the basis for the Austrian genus *Pachyacanthus*. The status of the Russian genus *Cetotheriomorphus* is as doubtful as its specific name implies, for it was founded upon a single small lumbar vertebra without epiphyses or neural spine. For the remaining genotypes portions at least of skulls were available to the original describer.

Five species, *rathkii, klinderi, helmersenii, priscum,* and *mayeri* were originally included in the subgenus *Eucetotherium*. Since *rathkii* is the genotype of *Cetotherium,* the species *helmersenii* may be selected as the genotype of *Eucetotherium*, for it is the only one of the four remaining species which is based in part upon a braincase. The architecture of the skull, in so far as it is preserved, is not materially different from that of *Cetotherium rathkii*. In reviewing the literature, we find that the generic names *Cetotherium* and *Plesiocetus*

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[23] J F Brandt Mem Acad Imp Sci St Petersbourg, (7), vol 20, no 1, 1873, pl 19, figs 1 4

[24] H Winge, Vidensk, Meddel naturhist Foren i Kjobenhavn, 1909, pp 1 37, pls 1-2

[25] F W True Smithson Misc Coll, vol 59, publ 2081, 1912, pp 1 8

have been used rather indiscriminately for fossil whalebone whales of Miocene and Pliocene age, some of which unquestionably belong in the family Balænopteridæ

Skulls of the Miocene genera *Cetotherium, Cephalotropis, Mesocetus, Metopocetus,* and the Pliocene *Amphicetus* have a rather short intertemporal region, and the lateral lambdoid crests are continued through a short sagittal crest with anterior temporal crests which diverge anteriorly and gradually disappear on the base of the corresponding supraorbital process The anterior limits of the temporal muscles on these skulls were sharply defined by these strong temporal crests Winge[26] obviously was mistaken in concluding that the skulls of all extinct finbacks have a temporal crest similar to that of *Cephalotropis coronatus* Cope, for there are quite a number, including *Plesiocetopsis megalophysum* and *Parietobalæna palmeri,* which either lack sharply defined temporal crests or do not exhibit any trace of them In all of these fossil cetotheres the backward thrust of the mesial portion of the rostrum has carried the ascending processes of the maxillæ and premaxillæ, as well as the nasals, beyond the level of the preorbital angles of the supraorbital processes

Van Beneden[27] has already pointed out that the genus *Cetotheriophanes* was founded on an error in observation on the part of Brandt, for the scapula of the species *cuvieri* is mutilated The skull of the genotype, *Balæna cuvieri,* is exceptionally well preserved and presents all the diagnostic features of the family Balænopteridæ The structural peculiarities of the skull do not warrant the retention of Brandt's generic name Balsamo Crivelli[28] apparently was the first author to place this species in its proper genus and it appears in his memoir as *Balænoptera cuvieri*

The genotypes of *Megapteropsis* and *Burtinopsis* are large species and appear to be related to the living humpback whale *(Megaptera)* The mandibular and cranial fragments, which formed the basis for *Mesoteras kerrianus,* are equal in size to the corresponding portions of the largest of the living fin-

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[26] H Winge, *op cit*, p 28

[27] P J Van Beneden, Bull Acad Roy Sci Belgique, (2) vol 20 no 12, 1875, p 3

[28] G Balsamo Crivelli, Gior d' I R Inst Lombardo Sci, Let ed Arti, vol 2, no 9, 1842, pp 133 138

backs Unfortunately a few fragments constitute all that is known of the skull of *Idiocetus guicciardinii*, but the earbones are sufficiently diagnostic to show that this genus belongs in the family Balænopteridæ

By employing this method of elimination in conjunction with diagnostic criteria, we find that there are three genera which should be critically examined to determine their relationships to the Temblor cetothere These genera, so far as can be judged by the illustrations of skulls representing them, exhibit affinities, more or less close, with the Temblor cetothere The genotypes of two of these cetotheres, *Heterocetus* and *Plesiocetopsis*, belong to the lower Pliocene, but that of *Parietobalæna* comes from the middle Miocene

Bones found during the excavations for the gas reservoir north of the village of Saint-Nicolas, Belgium, in separate groups at a depth of 4 meters and almost at the level of the clay in the lower zone of the super-clayey quick sand, formed the basis for the three species, *hupschii*, *burtinii*, and *garopii*, which Van Beneden proposed to include in his new genus *Plesiocetus* Some of these specimens were found on July 30, 1859, and the remainder a few days later These specimens apparently were deposited in the museum of the Catholic University at Louvain Van Beneden stated that the species of *Plesiocetus* are distinguished from other whalebone whales by their free vertebræ, by their having a scapula with a rudimentary coracoid process and well developed acromion situated high up and directed obliquely, and by a pyriliform tympanic bulla with an angular external surface He also concluded that the skull suggests a whale with a more robust and less tapering head

This diagnosis, however, is based chiefly on species which were later excluded from the genus *Plesiocetus* In 1872, Van Beneden[80] explicity stated that the generic name *Plesiocetus* is retained solely for *Plesiocetus garopii*, a whale of large size and very close to the living *Balænoptera*, and that the other originally included species are allocated to *Cetotherium* By this action, Van Beneden definitely fixed the species *garopii* as the genotype of *Plesiocetus* and all subse-

[80] P J Van Beneden, Bull Acad. Roy Sci. Belgique, (2), vol 34, no 7, 1872, p 242

quent opinions of Van Beneden and others do not alter the status of *Plesiocetus garopii* The present writer[30] overlooked this action by Van Beneden and designated the type of *Plesiocetus* as *Plesiocetus hupschii*

It is interesting to note, however, that Van Beneden[31] in October, 1877, stated that the illustrations for the three species of *Plesiocetus (garopii, burtinii,* and *hupschii)* were prepared before the specimens in the museum at Brussels were put at his disposal, and that the study of this material had caused him to change some of his previous determinations The volume dealing with the genus *Plesiocetus*[32] appeared in 1885, and in it Van Beneden apparently reconsidered his previously published opinion and returned the species excluded in 1872 to the genus *Plesiocetus,* but he failed to mention what disposition was made of *Plesiocetus garopii* It is apparent that the generic name *Plesiocetus* is not available for the group of cetotheres formerly associated together under this name

A year later when Brandt[33] published his memoir on the cetaceans of Europe, he concurred with the action of Van Beneden in 1872 and excluded all but *Plesiocetus garopii* from the genus *Plesiocetus* In this memoir Brandt proposed a new subgenus, *Plesiocetopsis,* for *Cetotherium,* and included in this new group *Plesiocetus hupschii, Cetotherium brevifrons, Cetotherium dubium, Plesiocetus burtinii,* and *Plesiocetus gervaisii* One *(Cetotherium brevifrons)* of these five species was referred by Van Beneden[34] in 1880 to the genus *Heterocetus,* and the present writer has selected this species for the type of that genus Of the four species which remain, two alone *(hupschii* and *burtinii)* are represented by adequate cranial material The second *(P burtinii),* orginally included in Van Beneden's genus *Plesiocetus,* is somewhat larger than *P hupschii,* having an estimated length of 5 meters Van Beneden states that he recognized portions of 4 individuals (axes) among the remains which formed the basis for *Plesiocetus*

[30] R Kellogg, Publ 348, Carnegie Inst Washington, 1925, p 51

[31] P J Van Beneden and P Gervais, Ostéographie des Cétacés, Paris, text, 1877, p 612, footnote

[32] P J Van Beneden, Description des Ossements Fossiles des environs d'Anvers. Pt. 4 Cétacés. Genre Plesiocetus Ann du Mus Roy d'Hist Nat de Belgique, vol 9, 1885, pp 1 40, pls 1 30

[33] J F Brandt, Mem Acad Imp Sci St Petersbourg (7), vol 20, no 1, 1873, pp. iii, 165

[34] P J Van Beneden Bull Acad Roy Sci Belgique, (2) vol 50, 1880, p 22

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burtinii No braincase was included among the co-types, and the complete list of specimens as given by Van Beneden is as follows 2 squamosal bones, a nearly complete mandible, 2 tympanic bullæ, atlas and axis (nearly complete) and 3 other cervicals, the first 3 dorsals, many lumbars, 3 caudals, many ribs, 2 incomplete scapulæ, a humerus, and a radius About 12 years later, Van Beneden[85] figured some of these specimens Whatever disposition may ultimately be made of this species, much depends upon its relationships to specimens subsequently referred to it

Among the specimens described and figured in 1885 is the braincase[86] of a cetothere (Cat No 127) in the Royal Museum at Brussels Van Beneden considered it to be an example of *Plesiocetus burtinii* This cranium is, therefore, a referred specimen and may or may not be identical with the original type material It seems advisable, therefore, to select one of the other originally included species as the genotype of *Plesiocetopsis* Upon comparing the illustrations of the braincase of *P. burtinii* with those of other cetotheres, it became apparent that the Belgian species is surprisingly like that of *Parietobalæna palmeri* in some respects This resemblance is especially striking when the skulls are viewed from behind Both skulls are characterized by the regular curvature of the lambdoid crests, by large postglenoid processes, and by small, wing-like exoccipitals The periotic bones are quite unlike those of *Parietobalæna* The precise relationships of *Plesiocetopsis burtinii* will remain uncertain until the characters of the dorsal and ventral surfaces are determined In so far as one can judge from available illustrations, this braincase differs from the Temblor skull in the shape of the supraoccipital shield

In view of these facts, *Plesiocetus hupschii* may be designated as the type of Brandt's subgenus *Plesiocetopsis*, which is hereinafter raised to full generic rank Portions of two skeletons of a cetothere, whose length was estimated as being from 3 to 3½ meters, formed the basis for *Plesiocetopsis hupschii* Van Beneden specifically mentions a basicranium intact as far

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[85] P J Van Beneden and P Gervais, Ostéographie des Cétacés, Paris Text, 1872, p 284, Atlas, 1872, pl 16, figs. 10-16

[86] P J Van Beneden, Ann Mus Roy d Hist Nat Belgique, vol 9 1885 pl 28, fig 1, pl 29 fig 1

as the sphenoid, both condyles nearly complete, and a squamosal with a well preserved zygomatic process The second specimen consists of the occipital portion of the skull with condyles, and the corresponding portion of an atlas This specimen is said to belong to a slightly larger individual Four or five vertebræ and fragments of ribs, belonging to an animal of the same size, are also mentioned The basicranium was figured by Van Beneden,[37] and reference is made to this illustration by Brandt[38] in 1873 The skull figured by Van Beneden[39] in 1885 is deposited in the Royal Museum at Brussels and bears the catalogue number 1239 The basicranium mentioned in 1859, and figured in 1872, by Van Beneden is one of the co-types, and should not be confused with the Brussels museum skull, referred in 1885 to *Plesiocetus hupschii* All comparisons hereinafter made are based on the co-type figured in the Ostéographie des Cétacés

An outstanding peculiarity of the basicranium of *Plesiocetopsis hupschii* is the presence of a robust process with a large concavity in the area corresponding to the paroccipital process Muscles arising from the atlas and thorax in recent balænopterine whales are inserted upon the paroccipital process and adjoining surface of exoccipital bone One might infer from analogous conditions in living mammals that these muscles had had tendinous insertions on this fossil skull This, in turn, would seem to indicate that more freedom of movement was permitted to the head of this fossil whale than is the case in recent balænopterine whales Assuming that the basicranium of *Plesiocetopsis hupschii,* the exact dimensions of which were not published, was carefully depicted by the artist, there is no reason to suppose that it differed in any fundamental respect from the skull which Cope named *Cetotherium megalophysum,* for the relative proportions of the component parts are essentially the same in both species These two skulls, however, differ from one another sufficiently to warrant their being referred to distinct species of the genus *Plesiocetopsis*

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[37] P J Van Beneden and P Gervais, Ostéographie des Cétacés, Paris, Atlas, 1872, pl 16, fig 17

[38] J F Brandt, Mem Acad Imp Sci St Petersbourg (7), vol. 20, no 1, 1873, p. 144

[39] P J Van Beneden, Ann Mus Roy d'Hist Nat Belgique, vol 9, 1885, pl. 21, fig 1

In the matter of relative proportions, the antero-posterior diameter of the temporal portion of each of these basicrania, as measured from the anterior margin of the squamosal in the temporal fossa to the posterior margin of the exoccipital, is nearly one-third greater than that of the Temblor skull The skulls of the St Marys and Belgian cetotheres have large condyles, the exoccipitals are extremely thick bones, and the position of the *foramen ovale* with respect to the temporal margin of the squamosal is approximately the same in both Furthermore, the periotic bones of these two fossil skulls have the same general type, and they exhibit a striking resemblance to the periotic of the Temblor cetothere

One analogous feature of the braincase of *Heterocetus brevifrons*[40] and the Temblor skull, is the height and extent of the forward thrust of the supraoccipital shield If the restoration suggested by Van Beneden is correct, the apex of the supraoccipital shield projects forward beyond the level of the extremities of the zygomatic processes The apical portion of this shield is smooth, apparently slightly depressed, and there is no indication of a vertical carina such as is found on the Temblor skull I have been informed by A Brazier Howell that this carina may suggest more differentiation of the muscles attached to the supraoccipital shield and possibly allow them more independent movement The condyles of the Belgian skull are relatively large, the distance between their outside margins being equivalent to about one-fourth of the breadth of the skull across the zygomatic processes The intertemporal region is short and the sagittal crest appears to be somewhat worn The lateral extension of the exoccipital, the downward prolongation of the postglenoid process, and the curvature and development of a crest on the posterior margin of the squamosal are in close agreement with similar portions of the Temblor skull One of the most obvious structural peculiarities of the *Heterocetus brevifrons* braincase seems to have been overlooked by previous investigators, if the illustration used by Van Beneden has been correctly interpreted There seems to be a deep fossa in the squamosal on the internal face of the zygomatic process above the glenoid articular surface. This

[40] P J. Van Beneden, Ann Mus. Roy d'Hist Nat. Belgique, vol 13, 1886, pl. 25, fig 1, pl 26, fig 1, pl 27, fig 1

fossa will be discussed more fully in a forthcoming paper on a cetothere skull from the Calvert formation of Maryland This feature alone would remove any possibility of generic relationship with the Temblor cetothere

Parietobalæna is the only Miocene genus, for which a skull is known, that is anywhere nearly contemporaneous with the cetothere from the Temblor formation hereinafter described, and both of these skulls lack shaply defined anterior temporal crests. In so far as our present knowledge goes, the Temblor skull is separable from *Parietobalæna* by a combination of characters which may have no great importance Aside from differences observable in the periotic bones of these two fossil cetotheres, the skull of *Parietobalæna* differs from the Temblor cetothere in having much more slender and more incurved zygomatic processes, a more triangular supraoccipital shield, prominent subhemispherical protuberances with obliquely placed concavity on lateral margins of the basioccipital, and exoccipitals with much thinner extremities

Our present knowledge of these small Miocene whalebone whales would seem to indicate that no generic name is available for the Temblor cetothere which in some respects resembles *Plesiocctopsis* and in others *Parietobalæna*

8 **Tiphyocetus temblorensis**[41] Kellogg, new genus and species

Holotype No 4355, Mus Calif Acad Sci from **Sharktooth Hill, Kern County, Cal**; Temblor, Miocene, Charles Morrice, Coll, 1924 The type skull consists of an incomplete braincase in a fair state of preservation The left side of the cranium, with its zygomatic process and the supraorbital processes of both frontals, is missing Portions of the rostrum were found associated with this braincase The right tympanic bulla and periotic are attached to the skull

Referred specimens No 4357, C A S, portions of a disarticulated skull in a fair state of preservation, the most important pieces of this skull being the basicranium, the presphenoid and posterior end of the vomerine trough, and the right squamosal region; No 4425, C A S, condyles and basi-

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[41] Τῖφυς, pilot of the Argo, κῆτος, whale

cronium, No 4440, C. A S, vertex of supraoccipital and sagittal portion of parietals; No 4439, C A. S, both exoccipitals, and fragment of basicranium with left pterygoid fossa, No 4353, C A S, right periotic; No. 4354, C. A S., left periotic, No 4356, C A S, right periotic, No. 11865, U S N. M, right periotic; No 4438, C. A S., incomplete left radius, No 4388, C A S, proximal end of right ulna, No 4436, C. A S, proximal end of left ulna; No 4442, C A S, incomplete sternum; No 4373, C A S, incomplete left scapula, No 4374, C A S, neck of right scapula, No 4375, C A S, neck of right scapula, No 4443, C A S, neck of right scapula, Nos 4390, 4391, 4393, C A S, phalanges, Nos 4376, 4378, C A S, humeri

Skull

In so far as the skull is concerned, this genus differs from *Plesiocetopsis* not only in the matter of the proportions of its component parts, such as wider temporal fossæ and a shortened antero-posterior diameter of the squamoso-exoccipital region between the level of the bulla and the zygomatic process, but also in having a more externally placed *foramen ovale* and the extremity of the alisphenoid reduced in the outer wall of the braincase in the temporal fossa

In general form this braincase appears to be intermediate in some respects between *Plesiocetopsis occidentalis* (Kellogg)[42] and *"Idiocetus" longifrons* Van Beneden.[43] Of all the Belgian Miocene cetotheres, for which skulls are known, *"Idiocetus" longifrons* seems to exhibit the closest resemblance to the Temblor cetothere in the general conformation of the braincase This upper Miocene species, however, exhibits no close relationship to the genotype, *Idiocetus guicciardinii,* from the upper Pliocene of Italy The correct generic allocation of *"Idiocetus" longifrons* is somewhat doubtful and may be held in abeyance until a general revision of related species is attempted The parietals of this skull meet in the intertemporal region to form a short sagittal crest, overspread the frontals in the interorbital region, and extend forward con-

[42] R Kellogg, Publ 348, Carnegie Inst Washington, 1925, pp. 50-56, text figs. 7-10

[43] P J Van Beneden, Ann Mus. Roy d'Hist. Nat Belgique, vol 13, 1886, pp. 72 76, pl 65, pl 66, fig 1; pl 67, fig 1, pl 68, figs 1 3

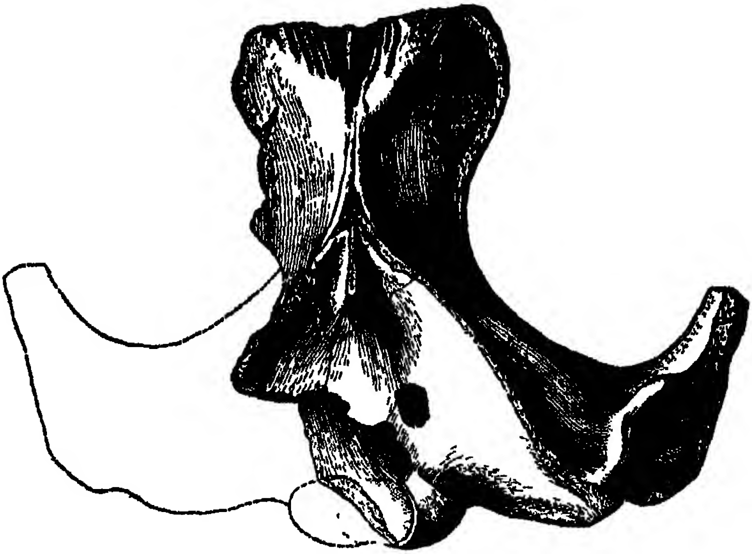

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Fig 74 Dorsal view of incomplete skull of *Tiphyocetus temblorensis*, No 4355, C A S, × 0 25

siderably beyond the level of the posterior margins of the supraorbital processes The frontals are narrowly exposed in the interorbital region between the anterior extremities of the parietals and the posterior extremities of the nasals, premaxillæ, and maxillæ The anterior temporal crests, which in some species mark the anterior limits of the areas from which the temporal muscles arise, are either weak or absent entirely When the skull is viewed from above the curvature of the posterior margin of the squamosal, the depression of the surface adjoining the zygomatic process, and the relative antero-posterior diameter of the body of the squamosal appear to agree with the corresponding portion of the Temblor skull, but the curvature of the anterior margin of the squamosal in the temporal fossa is quite different On the basis of the illustrations which accompany Van Beneden's memoir it would appear also that the skull of *"Idiocetus" longifrons* differs from that of the Temblor cetothere in that the supraoccipital shield has a more constricted apex, the vertical carina is longer, the extero-inferior angle of the postglenoid process is acute and

not rounded, and the lateral protuberances of the basioccipital are ovoidal and not elongated.

Dorsal view. The differential features of the Temblor skull are found in the architecture of the braincase (fig. 74). In contrast to the skull of *Plesiocetopsis megalophysum* (Cope), the extremity of the alisphenoid is reduced to a very small and narrow surface, the *foramen ovale* is placed nearer to the temporal edge of the squamosal, the temporal fossa as viewed from above is somewhat wider, the squamosal is shortened antero-posteriorly between the level of the bulla and the zygomatic process, and the width of the skull across the exoccipitals and zygomatic processes is greater.

Four skulls of a Calvert Miocene species of *Parietobalæna*, not designated at present by name because of our imperfect knowledge of a previously described cetothere from the same formation in Maryland, were available for comparison with the Temblor skull. They represent a species with a skull almost twice the dimensions of *Parietobalæna palmeri*. This cetothere had a wide temporal fossa, a broad basicranium, a squamosal shortened antero-posteriorly between the level of the bulla and the zygomatic process, a *foramen ovale* placed very close to the temporal margin of the squamosal, a basioccipital with wing-like descending processes, and exoccipitals with very thin extremities. It differs from the Temblor cetothere in having a different type of periotic, a basioccipital with wing-like processes instead of elongated lateral protuberances, a wider interval between the internal margins of the lateral processes of the basioccipital, slender, incurved zygomatic processes, an exoccipital with a much thinner extremity which is produced far below the level of the condyles, and much smaller condyles. The curvature of the postglenoid processes, on the other hand, is quite similar to that on the Temblor skull.

The loss of the orbital portions of the supraorbital processes of the frontals of the Temblor skull prevents detailed comparisons with some well known species, for their shape and direction, in addition to the contour of the temporal fossa, enable one to distinguish some species at a glance. At the base, each supraorbital process slopes gradually downward and outward from the median line of the post-narial region,

but, in case of the living whalebone whales, these processes are abruptly depressed at the base The frontals are excluded from the vertex of the intertemporal region, and their posterior borders are overspread by thin plates of the parietals, although the latter terminate behind the level of the sutures which mark the position of the nasals and the ascending processes of the maxillæ and premaxillæ These sutures also show that the basal portions of the nasal bones, as well as the ascending processes of the maxillæ and premaxillæ, were situated posterior to the rostral margin of the supraorbital processes There is an emargination on each frontal for the reception of a nasal bone The size and contour of the area occupied by the paired nasals shows that each of these bones was attenuated posteriorly

The parietals come in contact with each other on the vertex of the intertemporal region between the apex of the supraoccipital shield and the frontals, and are suturally united with the supraoccipital bone posteriorly and the squamosal inferiorly The sagittal crest is not as sharply defined on the type skull as on two other vertices referred to this species

Compared with *Plesiocetopsis megalophysum*, the supraoccipital shield of the Temblor skull is broader at the base and not quite so high The lateral or lambdoid crests of the triangular supraoccipital shield are well developed There is a well defined carina on the apical portion of this shield, on either side of which the surface is slightly depressed The condyles project beyond the level of the exoccipitals The squamosals and their zygomatic processes form the posterior and outer margins of the temporal fossæ The extremity of the right zygomatic process is missing and the external surface is eroded The lambdoid crest is continuous inferiorly with a crest that curves forward and outward on the posterior margin of the squamosal As in *Plesiocetopsis megalophysum*, the squamosal is strongly excavated below this carina

The fragments of the maxillæ associated with this cranium do not exhibit any unusual peculiarities

Posterior view From this aspect, the supraoccipital shield is seen to curve forward and upward, it is somewhat depressed in the center below the median carina on the apex. The exoccipitals are relatively small, coalesce with the supraoccipi-

tal above, and project outward and backward. Each exoccipital is suturally united in front with the corresponding squamosal, and inferiorly it is fused with the basioccipital. The shape of the *foramen magnum* appears to be similar to that of *Plesiocetopsis megalophysum,* judging from the curvature of the internal margin of the right condyle. This condyle, however, is quite different in general shape from that of the last mentioned cetothere It is considerably narrower at the apex than at the base, convex from side to side and end to end, and is set off from the exoccipital by a shallow excavation

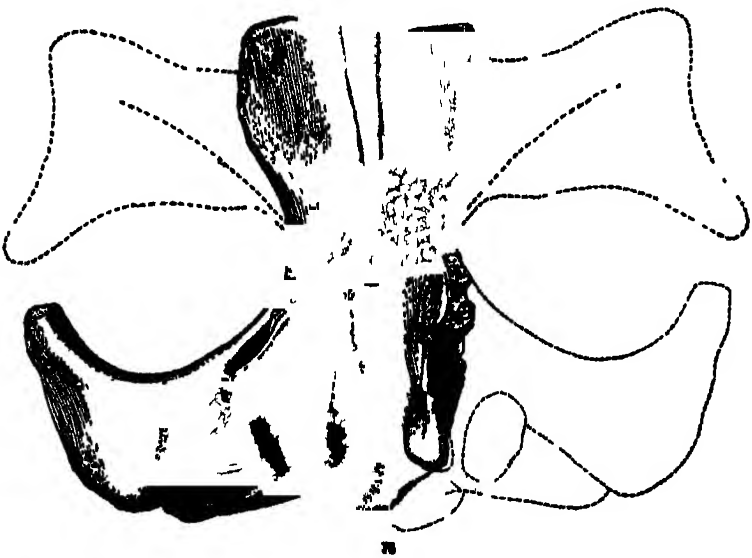
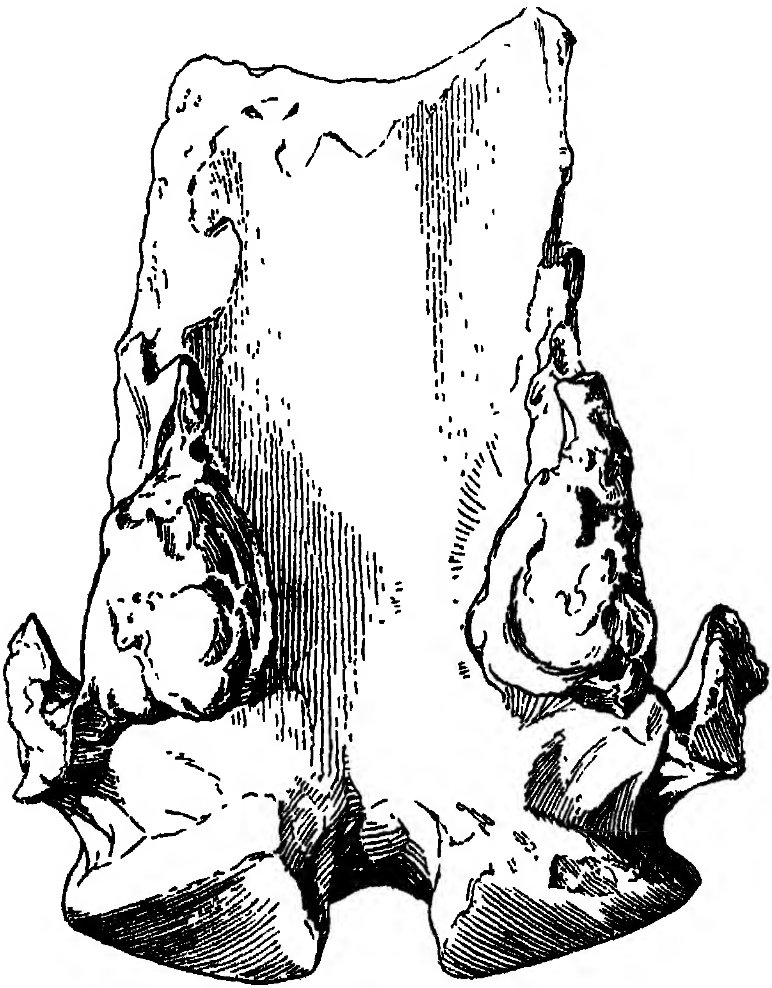


Fig 75 Ventral view of incomplete skull of *Tiphyocetus temblorensis,* No 4355, C A S, × 0 25

Ventral view The median region of the basicranium (fig 75), which is concave from side to side, is formed as usual by the basioccipital and basisphenoid The posterior horizontally expanded plate of the vomer, which overspreads the basisphenoid, is destroyed on both specimens The anterior margin of the basisphenoid is concave and it is separated from the presphenoid by an open transverse suture. Portions of the pterygoids remain attached to the lateral margins of the basisphenoid on the type skull, but their posterior extensions are

destroyed The latter contribute the internal walls of the pterygoid fossæ and abut against the lateral protuberances of the basioccipital These lateral protuberances are relatively smaller than those on the skull of *Plesiocetopsis occidentalis.* When complete, these pterygoid bones bound the median



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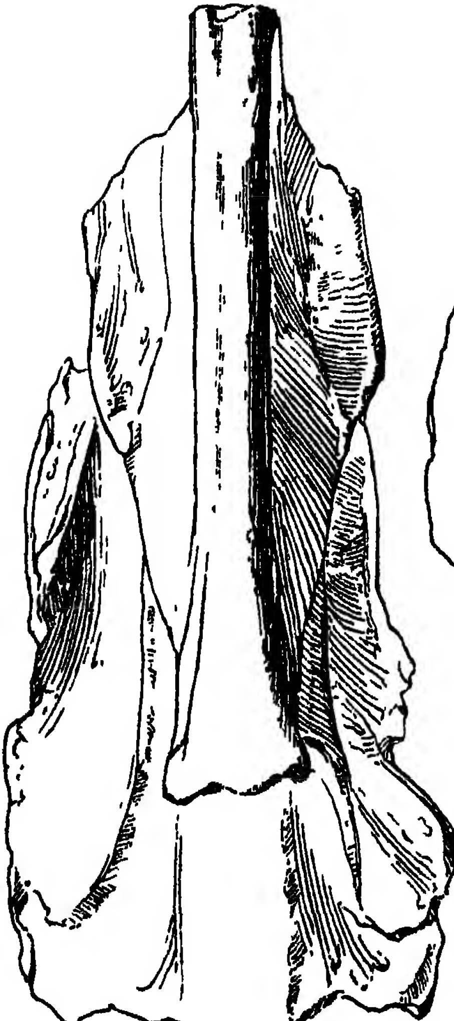
Fragment of skull of *Tiphyocetus temblorensis*, No 4357, C. A S., × 0 5 Fig 76 Ventral view of basicranium



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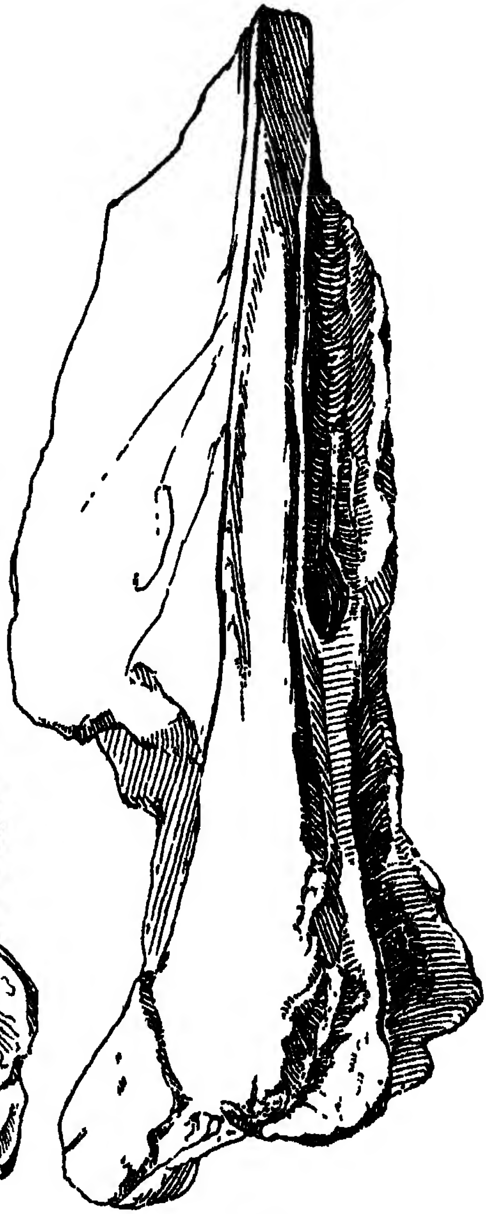


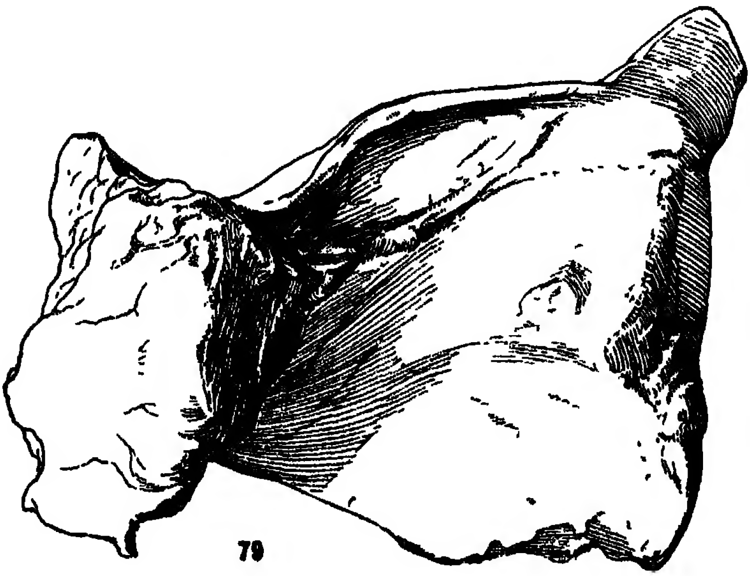
78

Fragments of skull of *Tiphyocetus temblorensis*, No. 4357, C A S, × 0 5 Fig 77 Ventral view of vomer and presphenoid Fig 78 Proximal fragment of left maxillary

region of the basicranium and take part in the formation of the lower borders of the choanæ.

On the type skull, the right pterygoid is in contact with the supraorbital process of the frontal, meeting the descending wall of the optic canal near its orifice The alisphenoid is hidden by the pterygoid, and its extremity is reduced to a narrow strip in the temporal fossa The roof of the pterygoid fossa is formed by the pterygoid Behind this fossa is the large tympano-periotic recess This recess is bounded by the squamosal externally, the exoccipital posteriorly, the basioccipital internally, and by the alisphenoid and overlying pterygoid anteriorly In the temporal fossa, the pterygoid is suturally united with the frontal and squamosal, and anteriorly it forms the posterior wall of the optic canal

The outer projection or zygomatic process of the squamosal is rather slender and flattened on its internal and external faces, the antero-internal portion of the squamosal is bifurcated to provide an orifice for the large *foramen ovale* The narrow lower branch or falciform process is suturally united



79

Fragment of skull of *Tiphyocetus temblorensis*, No 4357, C A S, × 0.5 Fig 79 Posterior view of right exoccipital

with the pterygoid on the outer wall of the pterygoid fossa. The broad upper portion is likewise sutured with the pterygoid The curvature of the anterior or temporal margin of the squamosal is most pronounced in front of the glenoid region and corresponds in this respect to the skull of *Plesiocetopsis megalophysum* Behind the falciform process there is a distinct emargination for lodging the anterior process of the periotic The glenoid articular surface is rather wide and is concave antero-posteriorly Behind this broad and rather

Measurements of Skulls (in millimeters)

	No 4355 C A S	No 4357, C A S
Greatest breadth of skull across zygomatic processes estimated	636 0	
Distance across skull between outside margins of exoccipitals, estimated	430 0	
Vertical height of skull (basisphenoid to apex of supraoccipital)	185 0	
Apex of supraoccipital shield to extero inferior angle of exoccipital	335 +	
Outside margin of extremity of zygomatic process to apex of supraoccipital shield	362 0	
Antero-inferior margin of *foramen magnum* to apex of supraoccipital shield	273 0	
Antero-inferior margin of *foramen magnum* to notch between frontals at base of nasals	360 0	
Least breadth of cranium between temporal fossæ	162 0	
Breadth of *foramen magnum*		57 0
Greatest distance between outer margins of occipital condyles		161 5
Greatest vertical diameter of right condyle	103 0	94 0
Distance from antero-inferior margin of *foramen magnum* to anterior margin of basisphenoid	200 0	202 0
Greatest distance across basioccipital between outside margins of lateral protuberances	123 0	148 0
Greatest depth of vomerine trough at anterior end of presphenoid		127 5
Distance between tip of postglenoid process and tip of zygomatic process of right squamosal	199 5[1]	228 5[1]
Apex of supraoccipital shield to notch between frontals at base of nasals	115 0	

[1] As preserved.

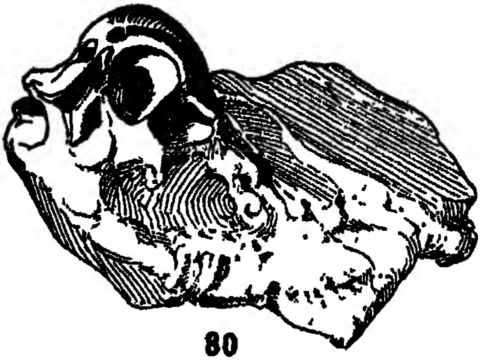
robust postglenoid process is a wide shallow channel for the external auditory meatus which commences at the postero-internal angle of the squamosal and curves outward The apophysis or posterior process of the periotic is wedged in between the posterior face of the squamosal and the flattened exoccipital The narrowing of the inferior edge of the exoccipital resulted in a corresponding decrease in the area available for the attachment of neck muscles The posterior or lacerated foramen is continuous externally with the tympano-periotic recess and is continued backward across the exoccipital as a broad groove between the poorly defined paroccipital process and the corresponding lateral protuberance of the basioccipital

PERIOTIC

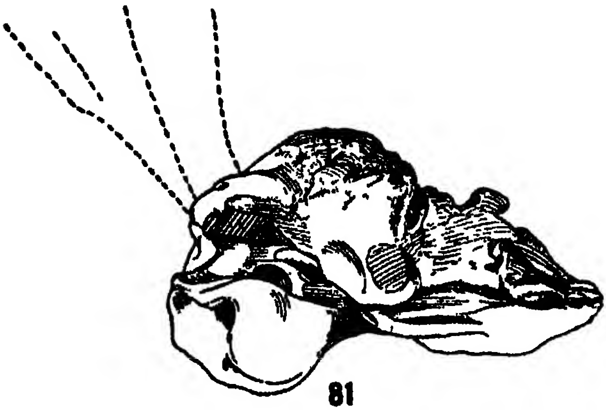
The periotic of this cetothere exhibits a surprisingly close resemblance to those of the St. Marys *Plesiocetopsis megalophysum* (Cope), and the Scaldisian (middle Pliocene) *Balænula balænopsis* [44] The periotics of these fossil whales exhibit the same side to side compression of the anterior process, but the periotic of *Balænula balænopsis* is distinguished by its larger size, by the greater antero-posterior diameter of the *pars cochlearis* and a larger cerebral orifice for the aqueduct of the cochlea The bullæ of both of these fossil whales are compressed from side to side and have a median longitudinal ventral ridge It would probably be difficult, if not impossible today, to explain the association of the periotic figured by Van Beneden with the other skeletal remains of *Balænula balænopsis* This right periotic lacks the posterior process, but the body is not much larger than that of the Temblor cetothere As a whole this Belgian periotic is quite unlike any known member of the family Balænidæ and the writer is inclined to suspect that it does not belong to *balænopsis* In so far as it is possible to make comparisons with the periotic of *Plesiocetopsis megalophysum,* it is practically identical with that of the Temblor cetothere

In the Antwerp Basin during the Miocene and early Pliocene there were at least three other species of fossil whales

[44] P J Van Beneden, Ann Mus Roy d'Hist Nat Belgique, vol 4, pl 3, figs 25 26, 1878.



80



81

Incomplete right periotic of *Tiphyocetus temblorensis*, No 4353, C A S, × 1 0 Fig 80 Cerebral view Fig 81 Inferior view

with periotics similar to those of the Temblor cetothere, but the bullæ referred to these species are quite different The periotic of the Diestian (lower Pliocene) *"Idiocetus" longifrons*[45] has a posterior process that closely resembles the corresponding process of the Temblor periotic, and the relative size and position of the aqueducts of the cochlea and vestibule also agree, but a comparison of the cerebral views shows that the body of the former is deeper and more rounded, the anterior process is shorter, and there are differences in the relative positions of the entrance to the *aquæductus Fallopii* and the internal acoustic meatus It is desirable to point out

[45] P J Van Beneden, *op cit*, pt 5, vol 13, 1886, pl 67, figs. 2, 3, 4

here that the periotic of the genotype, *Idiocetus guicciardinii*,[46] which belongs to the Astian (middle Pliocene) fauna of Italy, is so unlike the Belgian species that one might infer that the periotic of the latter either is erroneously associated with the other skeletal remains or else the generic allocation is incorrect The periotic of the Diestian *Amphicetus later*[47] has an exceedingly long and slender posterior process, a rather large *pars cochlearis*, and the cerebral orifice of the *aquæductus vestibuli* opens into a groove The periotic of the Diestien (lower Pliocene) *Plesiocetopsis hupschii*[48] has a much larger body, the outline of the combined anterior process and the body being distinctly triangular, and the cerebral orifice of the *aquæductus cochleæ* is larger, but the posterior process is not unlike that of the Temblor cetothere The periotic (figs 80, 81) of the Temblor cetothere possesses features which allocate the species in the group of small whalebone whales allied to *Plesiocetopsis hupschii* The limits and diagnostic criteria for this group are rather indefinite at present and are likely to remain so until all known material is critically studied It is unfortunate that so little attention was given to accurate methods of curatorial procedure at the time the specimens from the basin were passing through the hands of Du Bus, Van Beneden, their artists, and assistants

Portions of four periotics belonging to at least three different individuals are the basis for the following diognosis The posterior process (fig 75) is elongate, attenuated at both ends, and relatively narrow It is wedged between the exoccipital and the squamosal, while the body and the *pars cochlearis* project into the large recess behind the pterygoid fossa The posterior pedicle of the bulla is fused with the posterior process on the proximal end of the ridge which follows the anterior border Behind this ridge is the deep groove which marks the position of the facial nerve on its outward course The external denser portion or body of the periotic is compressed from side to side, and its depth is fully one-fourth greater than its width The external surface of the body is strongly convex and the internal surface is irregularly

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[46] G Capellini, Balene Fossili Toscane, III Idiocetus Guicciardinii. Mem. R. Accad Sci. Bologna, (6), 1905, vol 2, pl 1, figs 2, 3, 4

[47] P J Van Beneden, *op cit*, pt 5, vol 13, 1886, pl. 1, figs 1, 2, 3

[48] P J Van Beneden, *op cit*, pt 4, vol 9, 1885, pl 21, figs. 2 7

excavated The external surfaces of the body and anterior process are relatively smooth on two of these periotics, but are strongly rugose on the third. The *pars cochlearis* is small and not quite twice as long as broad; the ventral surface is convex and the external surface rises almost vertically from the inner margin of the *fenestra ovalis* The internal outline of the *pars cochlearis* of the periotic here figured (fig 80), viewed from the ventral side, is more strongly arched than on a second periotic (No 11865, U S. N M) The posterior face of the periotic is abruptly truncated above the circular *fenestra rotunda* The *fenestra ovalis* is partially encircled by a very narrow rim and is sunk below the level of the channel for the facial nerve A carina more distinct on one (No 11865, U S N M), than on another (No 4353, C A. S.) separates the channel for the facial nerve from the *fenestra ovalis* Small orifices of the semicircular canals can be seen at the bottom and on the outer wall of the vestibule On one of these periotics (No. 11865, U. S N. M.) there is a deep and narrow groove leading forward from the external rim of the *fenestra ovalis* to the notch between the *pars cochlearis* and the anterior process This groove is much less distinct on the periotic here figured and does not extend backward beyond the level of the anterior pedicle of the bulla The fossa for the stapedial muscle is broader than long and extends downward upon the internal face of the posterior process and the external face of the *pars cochlearis*

Bordering on the external margin of the epitympanic orifice of the *aquæductus Fallopii* (fig 81) is a large shallow concavity for lodging the head of the malleus The exact limits of this articular surface are not sharply defined and it appears to be continuous externally with the depression on the outer denser portion of the periotic In front of this facet is the base of the slender anterior pedicle which supports the bulla The *fossa incudis* appears to have been destroyed on all of these periotics The anterior process is compressed from side to side and rather deep, the extremity is emarginate on the periotic here figured and is straight on the others.

Some of the most important features of this periotic are found on the cerebral face Below the apex of the *pars cochlearis* is the internal accoustic meatus, at the bottom of

which is the spiral tract and a minute *foramen singulare* Because of its oblique position and the funnel-like shape of the meatus, the *tractus spiralis foraminosus* is largely hidden from a cerebral view A high thick transverse crest separates the large entrance to the aqueduct of Fallopius from the more centrally placed internal acoustic meatus. Posterior to the meatus is the small orifice of the aqueduct of the cochlea and above the latter is the large deep fossa into which the aqueduct of the vestibule opens Between this fossa and the entrance to the aqueduct of Fallopius is a rather prominent projection A large excavation is present on the cerebral face of the body above the entrance to the aqueduct of Fallopius There is a broad deep groove on the posterior face, bordered on each side by distinct crests, which commences at the posterior margin of the stapedial fossa and extends to the cerebral angle The smooth convex surface of the *pars cochlearis* does not extend as far as the rim of the internal acoustic meatus and the irregular margin thus formed accentuates the jagged appearance of the cerebral face

Measurements of Periotics (in millimeters)

	No. 11865, U.S N M Right	No 4353, C A S Right	No 4354, C A S Left	No 4356, C A. S Right
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	31 3	31 2		34 4
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	28 4	33 5		28 0
Distance between epitympanic orifice of *aquaeductus Fallopii* and tip of anterior process	([1])	50 0	51 0	40 5

[1]Extremity of anterior process missing.

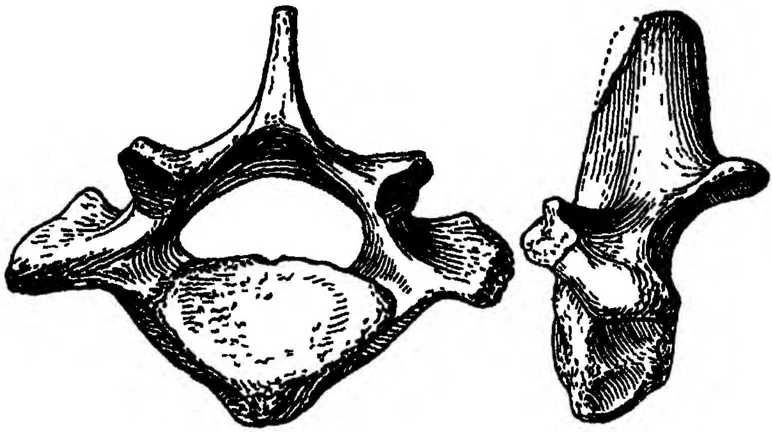
Bulla

The right tympanic bulla (fig. 75) attached to the skull is complete, and is characterized by the narrowness of the posterior end The involuted portion of the bulla is depressed below the level of the overarching, thin, outer lip and decreases in thickness anteriorly The dorsal surface of the involucrum is transversely creased and exhibits the usual convex undulation

The anterior pedicle is rather slender, and the posterior pedicle in cross section would appear "V"-shaped, with the apex behind A narrow groove separates the posterior conical apophysis from the sigmoid process, and, in front of the latter, the thin outer lip is traversed in a vertical direction by a rather broad groove The ventral profile shows that the bulla is depressed mesially. The ventral and external faces of the bulla form a continuous curved surface, but a fairly sharp angular crest separates the ventral and internal faces The posterior end of the bulla is strongly attenuated In contrast to the bulla of *Plesiocetopsis megalophysum,* where the eustachian angle corresponds to the antero-internal angle, the eustachian angle of the bulla of the Temblor cetothere is placed mesially on the anterior border The greatest length of this bulla is 87 8 mm., and that of the bulla of *Plesiocetopsis megalophysum* is 94 mm The bulla of the Calvert Miocene cetothere is considerably smaller, measuring less than 65 mm in length The greatest width of the Temblor bulla is 48 7 mm and its depth at the level of the posterior apophysis is 52 mm

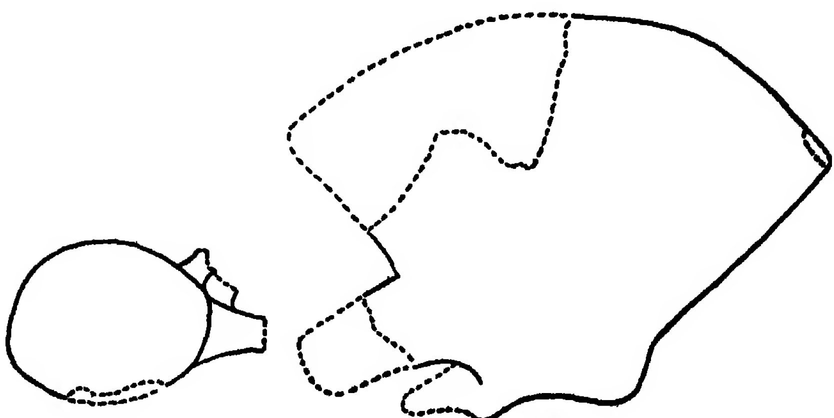
Scapula

It is not improbable that the differences observed in the four incomplete scapulæ (Nos 4373, 4374, 4375, and 4443, C A S) referred to this species are due to individual variation One (No 4373, C A S) of these is sufficiently complete to show the size and proportions of its component parts. The fan shaped blade (fig 85) is rather high, with a regularly convex vertebral margin and an essentially straight posterior margin above the neck The prescapular fossa is certainly very much reduced and may have been limited to the rather



82 83

Cervical vertebra of (?) *Tiphyocetus temblorensis*, No 4400, C A S, about × 0 5 Fig 82 Posterior view Fig 83 Lateral view



84 85

Scapulæ of *Tiphyocetus temblorensis*, × 0 5 Fig 84 Distal view of right scapula, No 4375, C. A S Fig 85 External view of left scapula, No 4373, C A S

broad anterior face The young of some species of recent finback whales have a scapula shaped like this fossil one, but in older individuals the vertebral margin is much less convex The base of the acromion process is quite broad, but its length is uncertain On this scapula most of the coracoid process is missing, but on one of the others (No. 4375, C A. S) the basal half of the long attenuated coracoid process, which arises close to the margin of the glenoid cavity is retained, and it is directed obliquely inward and downward The glenoid articular surface (fig. 84) on one of these scapulæ (No 4375, C A S.) is considerably expanded, the maximum diameters in the two directions being 101 mm and 80 mm The glenoid surface of the best preserved scapula measures 98 mm and 66 mm The greatest depth of the left scapula (No 4373, C A S) is about 240 mm, and the greatest width is estimated to be about 330 mm It is difficult to make proper allowances for age without having a large series for comparison, and, for the present, all four of these scapulæ may be referred tentatively to this species

Fore Limb

The remaining parts of the fore limbs of the Temblor cetothere are not readily distinguishable from those of a number of Pliocene and Miocene cetotheres found elsewhere In case of living whalebone whales, age differences are reflected in the bones of the fore limb, and limb bones without definite data are allocated correctly only with considerable difficulty A corresponding amount of age and individual variation may be expected in these fossil cetotheres The forearm of the Temblor cetothere is considerably longer than the humerus, and the ulna is longer than the radius No carpal bones were noted, but a number of phalanges of various sizes which belong either to this species or to one of the other cetotheres hereinafter described were sorted out for comparison The largest of these phalanges (No 4390, C A S) has a maximum length of 81 mm and a width of 56 mm The smallest (No 4393, C A S) measures 57 5 mm. by 42 5 mm. There is nothing peculiar about any of these phalanges as they are all expanded transversely at their extremities and flattened in a dorso-plantar direction

Humerus

The general shape of the humerus of this cetothere is quite similar to the right humerus referred by Van Beneden[40] to *Amphicetus rotundus*. The head and tuberosities on the proximal end of the left humerus (No 4376, C A S) are eroded away, but the right humerus (No. 4378) is fairly well preserved, with the exception of the greater tuberosity The humerus of this cetothere has a large globular head and a prominent greater tuberosity, but the lesser tuberosity is not as distinct as on a Calvert Miocene cetothere humerus The large head is not set off from the shaft by a well marked neck, and the groove between it and the greater tuberosity is rather broad Below this grove on the outer face of the humerus is a shallow and slightly roughened area for the infraspinatus muscle The lower portion of the shaft is rather broad and is flattened in an extero-internal direction The distal end is divided into two articular surfaces divided by a median crest The upper surfaces of the radius and ulna are applied to these facets The posterior profile of the humerus is strongly convex A low protuberance on the antero-external angle of the shaft below the greater tuberosity modifies the anterior profile The humerus of the Calvert Miocene cetothere has a large elongated fossa on the posterior face of the shaft about 18 mm above the ulna face, but the Temblor humeri lack this fossa It is possible that this fossa may mark the origin of one of the divisions of the triceps muscle, possibly the short head

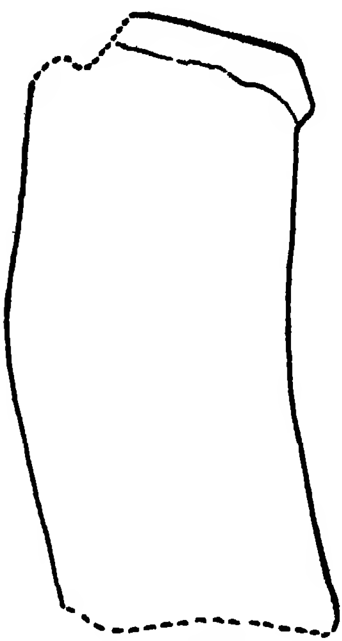
Measurements of Humeri (in millimeters)

	No 4376, C A S Left	No 4378 C A S Right
Greatest length	208 +	243 8
Extero-internal diameter of distal end	60 5	61 0
Antero-posterior diameter of distal end	104 0	109 5
Greatest diameter of head		96 0

[40] P J Van Beneden, Ann Mus Roy d'Hist Nat. Belgique, vol 13, 1886, pl 17, figs. 4 5

Radius

The left radius (fig 86) referred to this cetothere lacks the distal extremity As is usual with these cetaceans, it has a rather simple form, and its curvature conforms to that of the shaft of the ulna The shaft of the radius averages wider than that of the ulna The external and internal surfaces of the shaft are convex, forming crest-like anterior and posterior margins The maximum antero-posterior diameter of the shaft is 69 5 mm and the maximum extero-internal diameter is 41 5 mm The facet (fig 87) on the proximal end for articulation with the humerus is flattened There is also a well defined ulnar facet



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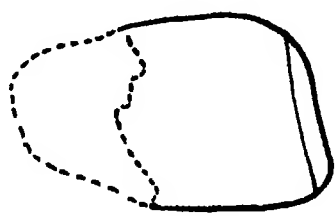
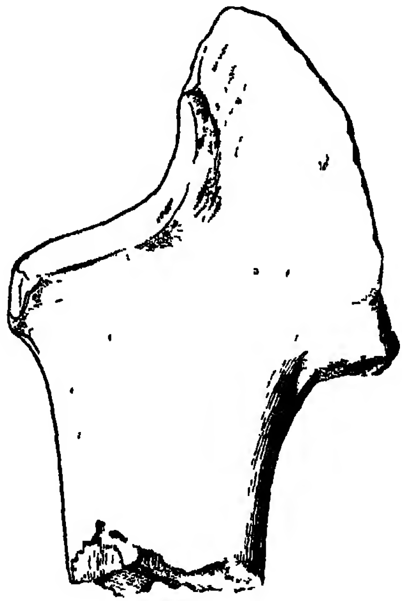


87

Incomplete left radius of *Tiphyocetus temblorensis*, No 4438, C. A. S, × 0 5 Fig 86. Internal view of shaft. Fig 87 Proximal view

ULNA

The proximal end of a right ulna (No 4388, C A S), and the proximal and distal ends of a left ulna (No 4436, C. A S) are ascribed to this species Their articular surfaces and proportions agree with the humeri described above In general proportions, the shaft of the ulna (fig 88) is not quite as slender as that of *Heterocetus affinis*[80] Both of these cetotheres have a well developed olecranon process projecting backward from the shaft of the ulna The lower portion of the greater sigmoid cavity is considerably broader than the upper, and the articular surface of the former extends over upon the external face The facet for the radius is broad and rather deep The distal end of the shaft is expanded in an antero-posterior direction and flattened from side to side The total length of the ulna when complete is estimated to be about 375



88

Fig 88 Internal view of right ulna of *Tiphyocetus temblorensis*, No 4388, C. A. S, × 0.5

[80] P J Van Beneden, Ann Mus Roy d'Hist Nat. Belgique, vol 13, 1886, pl. 24, fig 3

mm., the greatest diameter of the distal end is 87 mm., and the maximum extero-internal diameter of the lower portion of the greater sigmoid cavity is 46.5 mm.

Sternum

In view of the extraordinary variation which may be observed in sterna of recent whalebone whales, one should not attribute much importance to differences in general shape of these bones. True[51] has figured 25 sterna of *Balænoptera physalus,* many of which have quite unusual shapes. One or two bear a general resemblance to the sternum referred to the Temblor cetothere, particularly True's text figure 14. The sternum (No. 4442, C. A. S.) of the Temblor cetothere is wider than long, with rather broad posterior arm or stem. The right wing of the broad anterior portion was broken off and no contact can be found between two pieces included in the collection. Nevertheless this sternum appears to have had the anterior border entire, with a medial vacuity or perforation below it, and with the wings scarcely differentiated. The greatest length of this sternum is 178 mm., the greatest width (estimated), 225 mm.; and the maximum transverse diameter of the stem, 66 mm.

9. **Peripolocetus vexillifer**[52] Kellogg, new genus and species

Holotype. No. 4370, Mus. Calif. Acad. Sci. from **Sharktooth Hill, Kern County, Calif.**; Temblor, Miocene, Charles Morrice, Coll., 1924. Consists of the squamosal region on the right side, the corresponding portion of exoccipital, periotic and bulla, right occipital condyle, and a portion of basioccipital.

Referred specimens. No. 4358, right humerus, Nos. 4387, 4389, C. A. S., proximal end distal ends of left ulnæ.

Skull

The cranial fragments show that this cetothere had a considerably larger skull than *Tiphyocetus temblorensis.* The

[51] F. W. True, The whalebone whales of the western North Atlantic. Smithson. Contrib. to Knowledge, vol. 33, publ. 1414, 1904, pp. 140-141, text figs. 8-32.

[52] Περίπολος, a patrol; κῆτος, whale.

external margin of the extremity of the exoccipital is rounded and relatively thin The ventral surface of this bone behind the cochlear portion of the periotic is rather thick, affording a considerable surface for muscle attachment The combined zygomatic and postglenoid portions of the squamosal are produced much farther outward beyond the extremity of the exoccipital than in *Tiphyocetus temblorensis* Unfortunately the ventro-external angle of the postglenoid process and the extremity of the zygomatic process are missing, but the general shape is quite similar to that of *Tiphyocetus*. On the other hand, the ventral surface of the squamosal between the level of the bulla and the postglenoid process is very strongly convex, in contrast to the corresponding concave surface on the *Tiphyocetus* skull, and the curvature of the temporal margin of *Peripolocetus* is decidedly more convex. It would appear from the material at hand that this skull had a narrower temporal fossa than exhibited by *Tiphyocetus*

Viewed from behind, the curvature of the posterior margin of the squamosal is similar to that of *Tiphyocetus*, but the lambdoid crest rises more abruptly and the braincase swells out more noticeably above the level of the anterior process of the periotic The right condyle is rather large, concave from end to end and from side to side, but is not borne on a distinct neck It measures 107 5 mm in length and has a maximum width of 59 mm The inferior end is bluntly rounded and the superior end is pointed It attains its maximum width at a point about half way between the middle and the superior end Only a portion of the lateral protuberance on the right side of the basioccipital is preserved, but it is enough to show that it was relatively large

PERIOTIC

The ventral portion of the cochlear region of the right periotic, including the area occupied by the *fenestra rotunda* and aqueduct of the cochlea, is missing, but otherwise this bone is quite complete. The long posterior process with the expanded extremity is wedged as usual between the exoccipital and the squamosal. The body of the periotic is characterized chiefly by the large, swollen, anterior process which gives a characteristic shape to the whole bone The *foramen ovale* and

epitympanic orifice of the *aquæductus Fallopii* are located at about the same level, and the groove for the passage of the facial nerve posteriorly is limited to the internal surface of the posterior process

The large stapedial fossa is deep, sub-elliptical in outline, and is shut off from the broad and rather deep transverse trough on the posterior face of the periotic by a thin raised margin The spiral tract and the entrance to the aqueduct of Fallopius are placed within a common ovoidal meatus, and the transverse bony crest which separates the *aquæductus Fallopii* from the fossa occupied by the spiral tract does not rise half way to the level of the cerebral rim of the internal acoustic meatus The *foramen singulare* is placed at the bottom and within the fossa occupied by the *tractus spiralis forminosus* The spiral tract is strongly coiled and ends in a distinct *foramen centrale* There appears to be a distinct *area vestibularis inferior* The surface in the area occupied by the fossa for lodging the head of the malleus is very rugose and the margins of this fossa are very poorly defined The *fossa incudis* consists of a small irregular concavity located on a thin, inwardly projecting ledge The large swollen anterior process differs from that of *Tiphyocetus,* not only in its large size, but also in that it is turned inward almost at right angles to the body of the periotic, and its direction is parallel to that of the anterior process

Bulla

The left tympanic bulla associated with the cranial fragments appears rather small for so large a skull and may not have belonged to this species The heavy involucrum is creased transversely, concavo-convex from the rear forward, and gradually decreases in thickness anterior to the level of the sigmoid process The tympanic cavity which is bounded by the thin over-arching outer lip is rather narrow posteriorly, but widens at the level of the anterior pedicle, and then diminishes as it approaches the eustachian angle

The involucrum and the outer lip contribute the two sides of the V-shaped posterior process The posterior apophysis is small and blunt, and is separated from the sigmoid process by a short crease The sigmoid process is missing. Between the

sigmoid process and the anterior pedicle the outer lip of the bulla is deeply grooved Viewed from the external side, the ventral profile is slightly convex, and gradually merges with the strongly convex posterior profile There is a distinct angle between the anterior and ventral profiles The smooth convex ventral surface of the bulla passes into the internal and external surfaces without any perceptible change in curvature, although an irregular crease marks the ventral limits of the involucrum A fairly distinct longitudinal crest traverses the ventral surface at the anterior end, the posterior end is somewhat flattened The greatest length of this bulla is 89 3 mm ; greatest width, 45 5 mm ; greatest depth at level of posterior apophysis, 60 mm ; and the width of involucrum at level of anterior margin of posterior process is 40 mm

HUMERUS

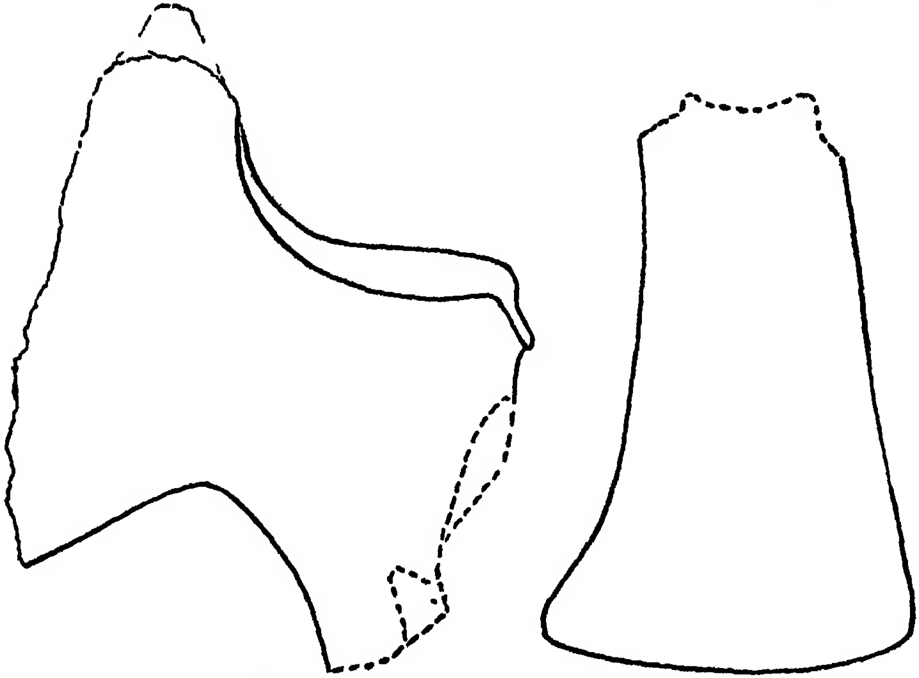
This right humerus (fig 89) is very well preserved and is somewhat larger than those referred to *Tiphyocetus temblorensis* The large globular head is set off from the shaft by a distinct neck and on the external face is separated from the greater tuberosity by a broad groove A large, rounded protuberance placed mesially on the proximal end of the humerus is identified as the lesser tuberosity The small rugose area, which marks the origin of one of the divisions of the triceps muscle—possibly the short head—is placed near the posterior border of the outer face of the shaft and this area is nearer to the head than to the ulnar facet The facets on the distal end of the humerus which articulate with the radius and ulna are similar in shape to those on the humerus of *Tiphyocetus*, although the humerus of the latter has a somewhat broader ulnar facet The measurements of the right humerus in millimeters are as follows greatest length, 274 5, extero-internal diameter of distal end, 121, antero-posterior diameter of distal end, 63, and greatest diameter of head, 107

ULNA

Proximal and distal ends of somewhat larger left ulnæ (Nos 4387, 4389, C A S) than those referred to *Tiphyocetus temblorensis* may belong to this cetothere The ole-

89

Fig 89 Right humerus of *Peripolocetus vexillifer*, No 4358, C. A. S., × 0.5



90 91

Fragments of ulnæ of (?) *Peripolocetus vexillifer*, × 0 5 Fig 90 Internal view of proximal end of left ulna, No 4389, C A S Fig 91 Distal end of left ulna, No 4387, C. A S

cranon process (fig 90) is quite large, and the upper portion of the sigmoid cavity forms an obtuse angle with the lower horizontal articular surface The radial facet is rather deep and is convex from side to side The external face of the shaft is convex and the internal flattened Most of the distal expansion (fig 91) is due to the enlargement of the posterior angle

10 **Parietobalæna (?) securis** Kellogg, new species

Holotype. Left periotic, without posterior process, No 4371, Mus Calif. Acad Sci from **Sharktooth Hill, Kern County, California**; Temblor, Miocene; Charles Morrice, Coll , 1924

Referred specimens Posterior process of left periotic, No 4579, C A S, and incomplete braincase, No 4372, C A. S

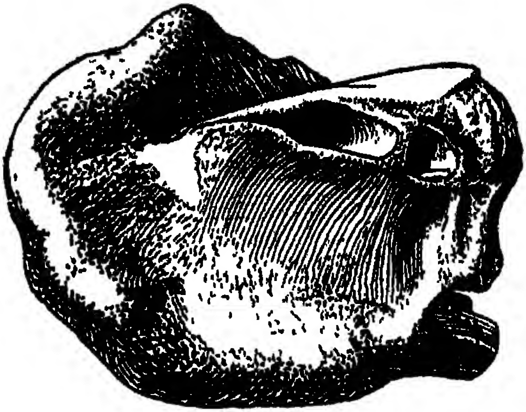
A badly eroded and damaged braincase is referred to this species The general aspect of the cranium is similar to that of *Parietobalæna palmeri,* but it is slightly larger than the latter The entire supraoccipital shield, with the exception of the apex, is destroyed The right exoccipital is preserved The right postglenoid process is complete though the zygomatic process is missing Although both condyles are imperfect, the right is more nearly complete than the left The small lateral descending processes of the basioccipital are knob-like The precise conformation of this skull is unknown

Periotic

Aside from having a much narrower groove or dorsoventral excavation on the posterior face above the stapedial fossa, this periotic differs from *Tiphyocetus temblorensis* in having the cerebral face noticeably flattened, a somewhat different profile of the *pars cochlearis,* when viewed from the cerebral side, and a considerably shorter anterior process In these respects it approaches the periotic of *Parietobalæna palmeri*[68] and until the skull of *securis* is found, it is tentatively allocated to the genus *Parietobalæna*

When contrasted with the periotics of *Tiphyocetus temblorensis,* the left periotic of *securis* is seen to have a much thicker body and anterior process, and a more convex external surface In the region of the anterior pedicle of the bulla, the extero-inferior margin of the anterior process is produced outward, forming a crest which projects beyond the external face In these respects this periotic (fig 93) bears a striking resemblance to those of *Parietobalæna* The *pars cochlearis* is larger than in *Tiphyocetus,* but it is not so strongly inflated in the region of the *fenestra rotunda* as in the latter The *fenestra rotunda* is large and produces a well marked indentation on the posterior profile The large elliptical *fenestra ovalis* is encircled by a narrow rim, which is set off from the stapedial fossa and the channel for the facial nerve by a rather broad osseous crest. The rim of the *fenestra ovalis* is not sunk below the level of the channel for the facial nerve as on

[68] R Kellogg, Proc U S Nat Mus, vol 63, publ 2483, 1925, pp 9 11, pl. 5

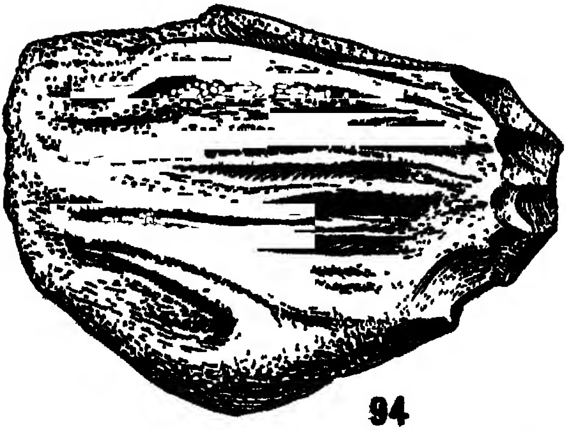


92

Fig 92. Cerebral view of incomplete left periotic of *Parietobalæna (?) securis*, No 4371, (C. A. S), × 1.0

93

Fig 93. Inferior view of incomplete left periotic of *Parietobalæna (?) securis*, No 4371, (C. A. S), × 1.0



94

Fig 94 Posterior process of left periotic of *Parietobalæna (?) securis*, No 4579, (C A S)

the periotic of *Tiphyocetus,* and the interval between the internal face of the *pars cochlearis* and the *fossa incudis* is somewhat wider Small orifices for the superior and posterior semicircular canals are located at the bottom and on the outer wall of the vestibule. A break, which fortunately passed through the vestibule, enabled the writer to trace the course of the semicircular canals and it was observed that they did not differ from those of recent whales. One structure was exposed which was heretofore unknown to the writer Within the substance of the body of the periotic and posterior to the vestibule is a blind aqueduct, which communicates with the portion of the *pars cochlearis* traversed by the cochlear duct, and, because of its position with reference to the periotic cistern and the semicircular canals, it is considered to house the *sacculus endolymphaticus.* This duct was not found in the periotics of the recent *Berardius* and *Tursiops,* or in several species of fossil porpoises It may possibly be present, however, in recent whalebone whales, but the writer did not have periotics of these whales which could be sectioned to determine the point The fossa for lodging the head of the malleus is placed in front of the epitympanic orifice of the aqueduct of Fallopius between the *pars cochlearis* and the anterior process, and not wholly on the anterior process as in *Tiphyocetus*

The channel for the facial nerve (fig 93), which curves backward from the epitympanic orifice of the aqueduct of Fallopius, is not set off from the fossa for the stapedial muscle by a carina and is largely concealed by the inwardly projecting border of the posterior process The fossa for the stapedial muscle is broad and quite deep, and terminates posteriorly at the emargination resulting from the development of a rather deep dorso-ventral groove on the posterior face Between the stapedial fossa and the *fenestra rotunda*, a sharp edged crest is developed on the posterior extension of the *pars cochlearis* which contributes the internal face for the groove on the posterior surface The poorly defined *fossa incudis* is placed opposite the epitympanic orifice of the aqueduct of Fallopius and at the apex of the excavation on the ventral surface of the outer denser portion of the periotic. The anterior process is foreshortened, and, in consequence of the curvature of the external face its extremity, is directed inward

Although the arrangement and position of the various structures on the cerebral face (fig 92) are approximately the same, the general appearance of this surface is quite unlike that of *Tiphyocetus temblorensis*, but it does correspond in all essential details with that of *Parietobalæna* The cerebral profile of the *pars cochlearis* is quite characteristic, being oblique and nearly straight in front, convex internally, and with a median projection posteriorly The rim of the deep internal acoustic meatus is raised above the surrounding surface and is placed some distance away from the entrance to the *aquæductus Fallopii* This meatus is somewhat narrower at the bottom than at the rim At the bottom and on the dorsal wall of this meatus is the rather large *foramen singulare* The spiral tract is short and strongly curved The groove or trough, which extends from the anterior rim of the internal acoustic meatus to the entrance of the aqueduct of Fallopius, is a remnant of the former course of the aqueduct and shows that the facial nerve has shifted forward in consequence of the general flattening of the cerebral face, thereby shortening the aqueduct which passes through the substance of the periotic on the anterior border of the *pars cochlearis* Behind the rim of the internal acoustic meatus is the minute orifice of the aqueduct of the cochlea, and above it is an elongate fossa into which

the aqueduct of the vestibule formerly opened, but which in this particular parotic is entirely closed

A posterior process of a left periotic (No. 4579, C A S), which bears a close resemblance to that of *Parietobalæna palmeri,* is referred to this species This short swollen process is somewhat flattened on its anterior face and strongly convex posteriorly

Measurements of the Periotic

Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*) ...	47.3 mm
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face) .	25 5 mm
Distance between epitympanic orifice of the *aquæductus Fallopii* and tip of anterior process .	39 6 mm

Suborder Odontoceti · Toothed Whales

The discovery of the skull of the large physeterid, *Aulophyseter morricei,* was one of the most important finds made by Mr Morrice in his excavations on Sharktooth Hill This physeterid may have been fairly numerous in the Temblor seas, for periotic bones of at least nine individuals were found by the collector The finding of a single periotic bone that apparently belongs to some squalodont is another interesting but not unexpected discovery Prior to the field work carried on by Mr Morrice, remains of squalodonts were unknown in the North Pacific region, although their occurrence in Tertiary formations of New Zealand, Australia, and Tasmania has been known for many years This find, if confirmed by the discovery of a determinable skull, will extend the geographic range of squalodonts to include most of the Miocene seas Numerous discoveries in the north and south Atlantic regions bear witness to their presence elsewhere in the Miocene period

Quite a variety of smaller porpoises frequented the Temblor seas in association with the archaic whalebone whales and the somewhat larger sperm whale The cranial peculiarities of these porpoises are as yet unknown to us On the basis of the

periotic bones it has been possible to distinguish at least nine species of porpoises Vertebræ and limb bones of some of these are included in the collection, but their relation to any particular porpoise is too uncertain to warrant any specific allocation. The apparent absence of the long-snouted porpoises, which are so characteristic of the Miocene formations in the Atlantic region, is quite puzzling None of these periotics agree with those of the long-snouted porpoises, *Eurhinodelphis* and *Cyrtodelphis* At least one, *Eurhinodelphis pacificus*,[84] of the long-snouted porpoises has been recognized by Matsumoto in the Miocene Shiiya formation of Japan Their occurrence in the Temblor fauna is to be expected The periotics hereinafter described are types commonly associated with skulls of short-snouted porpoises

Humerus

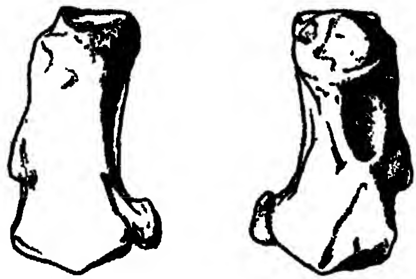
Six humeri of odontocetes were found in the collection, but it is obviously impossible to allocate any of them to any particular porpoise hereinafter described They form a part of our record of the Temblor pelagic fauna and are worthy of mention

95

Fig. 95 External or lateral view of large left humerus of an odontocete, No 4361, C. A. S × 0.5

[84] H. Matsumoto, Sci. Reports Tôhoku Imp Univ, ser 2, Geol., vol 10, no. 1, 1926, pp. 21-23, fig. 3, pl. 9, figs. 1-4.

The largest (fig 95) of these humeri is about the same size as that of *Eurhinodelphis bossi*. This humerus is damaged, with portions of the anterior and posterior surfaces of the distal end missing, and with the inner surface of the tuberosity eroded. The broadly oval head is not set off from the shaft by a distinct neck The infraspinous fossa of the humerus is rather broad Below this fossa is a well marked swelling



96 97

Right humerus of an odontocete, No 4363, C A S, × 0 5 Fig 96 Internal or medial view Fig 97 External or lateral view

A somewhat smaller right humerus (figs 96-97) possesses a peculiar process on the posterior angle of the distal extremity This process seems to be the proximal end of the olecranon process which has fused with the humerus When viewed from the front, the internal face curves from the distal end to the tuberosity but the external face is nearly straight The large deep infraspinous fossa is placed below the head and on the anterior half of the shaft The circular head does not have a distinct neck and is placed at about the same level as the tuberosity There is a conspicuous indentation on the anterior border of the distal end of the shaft and a transverse crest separates the trochlea for the radius from that for the ulna The process on the posterior angle of the distal end is rather thin and is set off from the trochlea for the ulna by a narrow groove In the region of the insertion of the masto-humeralis and the origin of the triceps muscles on the proximal end of the shaft are two small prominences

The third humerus (figs 98-99) has a somewhat stouter shaft than the preceding The circular head is placed con-

98

99

Right humerus of an odontocete No 4362, C A S, × 0 5 Fig 98 External or lateral view Fig 99. Internal or medial view

siderably below the level of the tuberosity and projects very little beyond the shaft On the anterior border of the head is a rather broad groove that extends inward to the tuberosity The deep infraspinous fossa comes in contact with the inferior margin of the head and is placed near the center of the shaft The swelling on the anterior face of the shaft above the distal end presumably marks the insertion of the deltoid muscle The trochlea for the radius and that for the ulna are separated by a complete mesial transverse crest

100

Fig 100 External or lateral view of left humerus of an odontocete No 4364, C. A S, × 0 5.

The upper end of the shaft of this left humerus (fig 100) is eroded The head is slightly lower than the tuberosity and there is no distinct neck Furthermore, the deep infraspinous fossa does not meet the lower margin of the head as on the humerus just described, but it does have a prominent swelling on the anterior face The transverse crest separating the

trochlea for the radius from that for the ulna is not complete The curvature of the outer and inner surfaces of the shaft are similar to that of the third humerus.

There are, in addition, two slender badly worn humeri of some small odontocete These humeri have a shallow infraspinous fossa and a low transverse crest separating the trochlea for the radius from that for the ulna The ulna trochlea extends upward upon the posterior face of the distal extremity

Measurements of Humeri (in millimeters)

	No 4361, C A S Left	No 4362, C A S Right	No 4363, C A S Left	No. 4364, C A S Right
Greatest length (greater tuberosity to distal margin)	103 0	65 5	72 5	66 0
Extero-internal diameter of shaft at level of lower margin of infraspinous fossa	31 5	20 0	20 5	19 5
Antero posterior diameter of distal end of shaft		33 7	40 0	32 5
Extero-internal diameter of proximal end of humerus	55 +	40 0	42 8	41 5

Ulna

Two fairly complete ulnæ and the proximal ends of four others are referred to odontocetes All of these ulnæ are smaller and shorter than those of cetotheres

The largest (fig 101) of these ulnæ is short, broad, and compressed It is quite broad at the distal end and is narrowest below the facet for articulation with the radius From its free posterior border, near the proximal end, rises the compressed olecranon process which unfortunately is largely destroyed The sigmoid cavity for the humerus is slightly curved and its surface is eroded This ulna belongs to a rather large odontocete, while all of the periotic bones hereinafter described are unquestionably those of porpoises of small and medium size Judging from its shape, it would appear

101

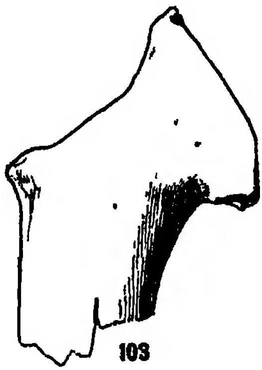
Fig 101 Internal or medial view of large right ulna of an odontocete, No 4365, C. A S, × 0 5

102

Fig 102. Internal or medial view of right ulna of an odontocete. No. 4366, C. A. S., × 0.5.

that this ulna might possibly belong to a young individual of *Aulophyseter morricei*

The ulna here figured (fig. 102) has a rather slender shaft It is compressed from side to side and is expanded at the distal end It is considerably larger than the same bone of the recent *Tursiops truncatus* The facet for articulation with the head of the radius projects considerably beyond the anterior face of the shaft The proximal end of the thin, compressed olecranon process is missing With the exception of the proximal border, the sigmoid cavity for articulation with the humerus is nearly straight

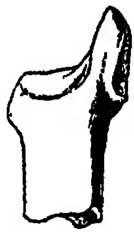


103

Fig 103 External or lateral view of left ulna of an odontocete No 4437, C A S., × 0.5

The proximal end of a left ulna (fig. 103) of about the same proportions as that of *Squalodon* has a fairly complete olecranon process The shaft is convex externally and flat internally It lacks a distinct fact for articulation with the radius and the broad sigmoid cavity is subvertical on its proximal third This ulna is tentatively referred to *Squalodon errabundus*

This ulna (fig 104) lacks the distal end of the shaft In size it corresponds rather closely with that of the recent *Tursiops truncatus* It differs from the latter, however, in having a less flattened shaft and in the entire absence of a groove on the internal face below the sigmoid cavity The olecranon process is rather narrow and ends in a proximal



104

Fig 104 External or lateral view of left ulna of an odontocete No 4368, C A S, × 0 5

pointed tip The sigmoid cavity is broad and strongly curved, with a side to side curvature It has a large facet for articulation with the radius

A small left ulna (fig 105) likewise lacks the distal half of the shaft, but possesses the upper end of the olecranon process It differs from the following ulna (No 4367, C A S) in having a trace of a groove on the internal face below the sigmoid cavity The facet for articulation with the radius is

105

Fig 105 External or lateral view of left ulna of small odontocete No 4435, C. A. S., × 0 5

broad and quite rugose The sigmoid cavity is raised along the median line and the narrow proximal half is turned almost at right angles to the broad distal half The shaft is elliptical in cross section.

The corresponding portion of another small left ulna is characterized by having a narrower sigmoid cavity than the preceding, a greatly reduced olecranon process, a groove on the internal face below the radial facet, and a markedly flattened shaft.

The proximal end of another small left ulna (No 4367, C A S) corresponds fairly well in the curvature of the lower end of the olecranon process, in the curvature of the sigmoid cavity, and in the proportions of the shaft with the corresponding bone of *Delphinodon dividum*[55] It is barely possible that this ulna may belong to *Œdotus mirus*, the porpoise hereinafter described from a periotic bone, for the periotic resembles that of *Delphinodon dividum* in some respects

Measurements of Ulnæ (in millimeters)

	No 4365, C. A S Right	No 4366, C A S Right	No 4437, C A S Left	No 4368, C A S Left	No 4435, C A S. Left	No 4367, C A S. Left
Length, proximal end sigmoid cavity to distal end	153 0	116 0				
Breadth at proximal end	62 +	54 5	69 0	34 0	26 0	31 0
Breadth at distal end	81 7	49 0				
Least antero-posterior diameter of shaft	42 0	25 7	48 0	20 0	16 0	18 5
Length of olecranon			58 4	29 5+	23 +	

PHALANGES

Several flattened phalanges which probably belong to odontocetes were sorted out of the collection made by Mr Morrice Two of them have a distinctly hour-glass outline The largest of these (No 4394, C. A S.) measures 45 mm in length, 35 mm in width at the base, and the least diameter is 19 mm The other phalanx (No 4567, C A S) is 35 mm long and 26 5 mm wide at the base. A third phalanx (No. 4564, C A S.) is very slightly constricted, and it measures 55 mm in length and 31 mm in width at the base. The other phalanges are broken and worn, and present no special peculiarities

[55] F W True, Description of a new fossil porpoise of the genus *Delphinodon* from the Miocene formation of Maryland. Journ Acad Nat Sci. Philadelphia, (2), vol 15, 1912, p 184, pl 25, fig 4

Vertebræ

Quite a number of odontocete vertebræ were collected by Mr Morrice, but most of them are imperfect The neural spines, transverse processes, and, in many cases, the neural arches as well are either damaged or missing

One series of 15 vertebræ consists of two dorsals (Nos 4495, 4496, C A S), one lumbar (No 4497, C A S), and twelve caudals (Nos 4498 to 4509, C A S) These vertebræ are considerably smaller than the corresponding vertebræ of *Priscodelphinus atropius*, and the centra are relatively longer The dorsal vertebræ have the centra strongly constricted near the middle and the dorsal margins of both epiphyses are nearly straight The largest dorsal (No 4496, C A S) measures 56 mm in length and the height of the centrum posteriorly is 35 mm The lumbar vertebra (No 4497, C A S) has broad transverse processes and an indistinct longitudinal keel on the inferior face It is 68 5 mm long and the height of the posterior face of the centrum is 41 mm The five anterior caudals (Nos 4498 to 4502, C A S) have the transverse processes pierced basally by a foramen Their neural canals are narrow and high, and progressively diminish in height Large descending processes for articulation with the chevron bones are developed on the inferior surface at the posterior end of the centrum The largest of these caudals (No 4499, C A S) measures 55 5 mm in length, and the greatest height of the centrum posteriorly is 40 5 mm Two smaller caudals (Nos 4503 and 4504, C. A S) retain vestiges of the neural arches and possess a pair of longitudinal plate-like descending processes on the inferior surface of the centrum, but lack transverse processes Five terminal caudals (Nos 4505 to 4509, C A S), varying in length from 28.5 mm to 25 5 mm, lack a neural canal The centrum of each of these caudals is pierced dorso-ventrally by paired vertebrarterial canals that open inferiorly into a deep longitudinal groove

Another series of five vertebræ (Nos. 4530, 4531, 4546, 4532, 4533, C A S) have rather slender centra. This series includes four lumbars and one caudal All of the lumbars have a prominent longitudinal inferior carina, on each side of which is a broad diagonal groove that extends from the

middle of the centrum to the posterior basal angle of the transverse process Although none of these vertebræ has a complete neural arch, there is sufficient evidence to show that the neural canal was very narrow The neural arches and transverse processes approximate the anterior margins of the centra The single caudal vertebra (No 4533, C A S) has rather high neural arches, a low neural spine, and a very small neural canal The transverse processes are largely destroyed, but were pierced basally by a foramen The ventral surface of the centrum is eroded The largest lumbar (No 4546, C A S) measures 58 2 mm in length

Fifteen caudal vertebræ (Nos 4510 to 4522, 4527, 4528, C A S) are thought to represent still another type of porpoise These caudals do not represent a continuous series and may have belonged to several individuals The largest caudal (No 4511, C A S) measures 59 mm in length and the smallest (No 4522, C A S) 25 mm The larger caudals have their transverse processes pierced at the base by a foramen They possess large descending processes for the chevrons and have narrow neural canals The caudals near the posterior end of the series have very low neural arches, the neural canal is nearly closed, and the neural spine is very low With one exception, all of these caudals lack vestiges of the transverse processes These caudals possess a pair of longitudinal plate-like descending processes on the inferior surface of the centrum The three small terminal caudals (Nos 4520 to 4522, C A S) have a pair of thick longitudinal ridges on the inferior surface of the centrum.

Four badly eroded lumbar vertebræ (Nos 4523 to 4526, C A S) differ from those heretofore described in having more robust centra, although the largest of these vertebræ hardly measured more than 65 mm in length when complete

Among the remaining miscellaneous vertebræ are six which belong to a much smaller porpoise than any of those heretofore mentioned A small dorsal vertebra (No 4534, C A S), about 30 mm in length, has the centrum contricted mesially It lacks all of its processes A posterior dorsal (No 4539, C A S) referred to the same porpoise is likewise incomplete It measures 43 5 mm in length On the four lumbars (Nos. 4538, 4537, 4536, and 4540, C A S), the longitudinal

inferior carina progressively increases in depth. The length of the largest No 4538, C A S) of these lumbars is 48 mm. and the smallest (No 4540, C A S) is 41 mm All of these vertebræ have rather slender centra

A single small caudal vertebra (No 4541, C A S) has a high neural spine, small neural canal, and short transverse processes The centrum has deep concavities above and below the transverse processes It measures 35 5 mm in length, and the distance from the tip of the neural spine to the inferior surface of the centrum is 51 5 mm

Fragments of an atlas (No 4543, C A S), two axes (Nos 4544, 4545, C A S), and the centrum of a cervical vertebra (No 4542, C. A S) belong to some small porpoise In addition to the foregoing vertebræ, there is a rather large caudal vertebra (No 4529, C A S) which indicates the presence of a porpoise of about the same proportions as *Priscodelphinus atropius*

KEY TO PERIOTIC BONES OF PORPOISES FROM THE TEMBLOR FORMATION, SHARKTOOTH HILL, NEAR BAKERSFIELD, CALIFORNIA

1 Extremity of anterior process resembles the handle-end of a crutch when viewed from in front, between the *fenestra ovalis* and the deep concave fossa for the head of the malleus is a narrow crescentric excavation which commences near the epitympanic orifice of the *aquæductus Fallopii* and extends downward upon the external face of the *pars cochlearis*, the large egg-like accessory ossicle is firmly ankylosed to the ventral face of the anterior process, postero-internal angle of ventral facet on posterior process, when complete, reaches to the level of internal margin of stapedial fossa, cerebral face of outer denser portion of periotic nodular, greatest antero-posterior diameter of *pars cochlearis* 20 mm or more *Aulophyseter morricei* (p 361)

Extremity of anterior process either pointed, rounded, or abruptly truncated, greatest antero-posterior diameter of *pars cochlearis* less than 20 mm 2

2 Extremity of anterior process (antero-ventral angle) attenuated and pointed 3

Extremity of anterior process rounded, or abruptly truncated and compressed from side to side 4

3 No incisure on posterior face above and internal to stapedial fossa, anterior process swollen, entrance to aqueduct of *Fallopius* constricted; cerebral and external faces of outer denser portion of periotic form a continuous smooth convex surface, internal acous-

tic meatus cucurbital in outline, transverse diameter, excluding posterior process, 24-26 mm *Squalodon errabundus* (p. 373)

A deep incisure on posterior face above and internal to stapedial fossa; apical portion of anterior process on ventral face grooved longitudinally to support outer lip of bulla; groove for facial nerve sinks below level of external rim of *fenestra ovalis*, entrance to aqueduct of Fallopius constricted, transverse diameter, excluding posterior process, less than 21 mm *Liolithax kernensis* (p. 375)

4 A subtriangular flattened or depressed area on cerebral face behind internal acoustic meatus, the apex of which is occupied by the fossa inclosing the cerebral orifice of the aqueduct of the vestibule, a pit is usually present on the posterior face above the stapedial fossa 5

Not as in preceding, and with orifice of aqueduct of vestibule in closer proximity to rim of internal acoustic meatus 7

5 Anterior process with longitudinal carina on cerebral face, groove for facial nerve does not sink below level of external rim of *fenestra ovalis*, posterior face of posterior process concave above ventral facet, a low crest is present on antero-external border of ventral face of *pars cochlearis* opposite to the facet for the accessory ossicle 6

Anterior process without longitudinal carina on cerebral face, *pars cochlearis* strongly inflated posterior to aqueduct of cochlea, a deep pit on posterior face above stapedial fossa, stapedial fossa bounded internally by a thin-edged crest, a well defined crest is present on antero-external border of ventral face of *pars cochlearis* opposite to the facet for the accessory ossicle *Œdolithax mira* (p. 378)

6 Triangular depressed area behind internal acoustic meatus sharply defined, with apex produced beyond fossa inclosing cerebral orifice of aqueduct of vestibule *Lamprolithax simulans* (p. 381)

Triangular depressed area behind internal acoustic meatus less sharply defined and with apex not produced beyond fossa inclosing cerebral orifice of aqueduct of vestibule *Lamprolithax annectens* (p. 383)

7 Greatest diameter of periotic (tip of anterior process to apex of ventral facet on posterior process) more than 25 mm 8

Greatest diameter of periotic (tip of anterior process to apex of ventral facet on posterior process) less than 25 mm, cerebral face of outer denser portion of periotic flattened; entrance to *aquaeductus Fallopii* constricted, no pit is present on posterior face above stapedial fossa *Nannolithax gracilis* (p. 386)

8 Cerebral face of outer denser portion of periotic broad, distinctly flattened and depressed external to internal acoustic meatus and general plane of this surface forms a right angle with the external surface, a subconical swelling posterior to cerebral orifice of aqueduct of cochlea, no pit is present on posterior face above stapedial fossa, facial canal sinks below level of external rim of *fenestra ovalis* *Platylithax robusta* (p. 388)

Cerebral face of outer denser portion of periotic convex, with the outer two-thirds more or less flattened 9

9. Outline of internal face of anterior process as viewed from the cerebral side distinctly convex, posterior face of posterior process rounded or flattened above ventral articular facet 10
   Outline of internal face of anterior process as viewed from the cerebral side nearly straight, a pit on posterior face above stapedial fossa, posterior face of posterior process excavated and concave above ventral articular facet *Loxolithax sinuosa* (p. 390)
10 Antero-external border of ventral face of *pars cochlearis* traversed by a low crest, a pit or slit-like depression is present on posterior face above stapedial fossa *Grypolithax pavida* (p 396)
   Antero-external border of ventral face of *pars cochlearis* smooth, without any trace of a crest, posterior face depressed above stapedial fossa, but no pit is present *Grypolithax obscura* (p 393)

Family PHYSETERIDÆ Sperm Whales

11 **Aulophyseter morricei** Kellogg[16]

Type specimen No 11230, Division of Vertebrate Paleontology, U S Nat Mus. The type consists of a skull in a fair state of preservation The supraorbital process of the left frontal and overlying maxilla, the left lachrymal and jugal, and the extremity of the rostrum are missing. Four enamel-crowned teeth and a right periotic were found near this skull

Paratype Portions of the skull (No 11313, U S N M.) of a young whale or embryo were found about 20 feet from that of the adult

Referred specimens Right periotic, No 10853, U S N M , right periotic, No 2794, C. A S ; right periotic, No 2795, C A S , left periotic, No 2796, C. A S , right periotic, No 2797, C A S , right periotic, No 2798, C A S., left periotic, No 2799, C A S., right periotic, No 2800, C A S ; right periotic, No 2801, C A S , (?) mandibular teeth, Nos 2802, 2803, 2804, 2805, 2806, 4575, 4576, C A S

The skull (fig 106) is especially interesting, for it demonstrates that the reduction of the maxillary dentition had commenced as early as the Middle Miocene The top of the skull has been adjusted to lodge a fat or spermaceti cushion, and, in correlation with this peculiar structure, the relative proportions and relations of the bones forming the dorsal surface have

[16] R. Kellogg, Study of the skull of a fossil sperm whale from the Temblor Miocene of southern California Publ 346, Carnegie Inst Washington, 1927, pp 1 23, pl 1 9

been altered to form a large supracranial basin. The dorsal cranial elements are markedly asymmetrical and the left narial passage is much larger than the right

SKULL

About four feet in length, distal constriction of rostrum coextensive with the shallow, closely approximated, alveolar grooves; no trace of distinct or vestigial alveoli for lodging teeth in the upper jaw, a large maxillary incisure and a smaller posterior maxillary foramen, more or less flattened, broad, premaxillaries forming the dorsal surface of median portion of rostrum and shallow supracranial basin, right premaxillary expanding behind narial passages into a broad thin plate which is applied to upper surface of frontal and overlaps the maxillary along its internal margin, left premaxillary turned out of its course by enlargement of the corresponding narial passage and apparently terminated near posterior margin of this passage, premaxillaries forming extremity of rostrum, maxillary relatively thick posterior to antorbital notch and forming lateral wall of supracranial basin, supracranial basin limited posteriorly by transverse crest of supraoccipital and continued laterally to elevated portion of maxillaries, postnarial portion of right maxillary not meeting the left in the middle line, left narial passage much larger than the right, tapering zygomatic processes placed rather far forward, short temporal fossa, parietal excluded from vertex of skull, two orifices for infraorbital system on ventral face of maxillary, lachrymal narrow, firmly lodged between maxillary and supraorbital process of frontal, and fused with broad jugal which does not project much more than half way across orbit, palatine bones large, broad, and not projecting forward beyond anterior margins of anterior infraorbital orifices, pterygoids with large hamular processes, falcate processes of basioccipital projecting beyond level of condyles, a deep jugular incisure, alisphenoid thin, large, expanded horizontally, bounded anteriorly by supraorbital process of frontal, suturally united posteriorly with squamosal, and in contact with anterior surface of exoccipital, no tympano-periotic recess, optic canal confluent with sphenoidal fissure, *foramen ovale* pierces basal portion of alisphenoid, large jugulo-acoustic canal

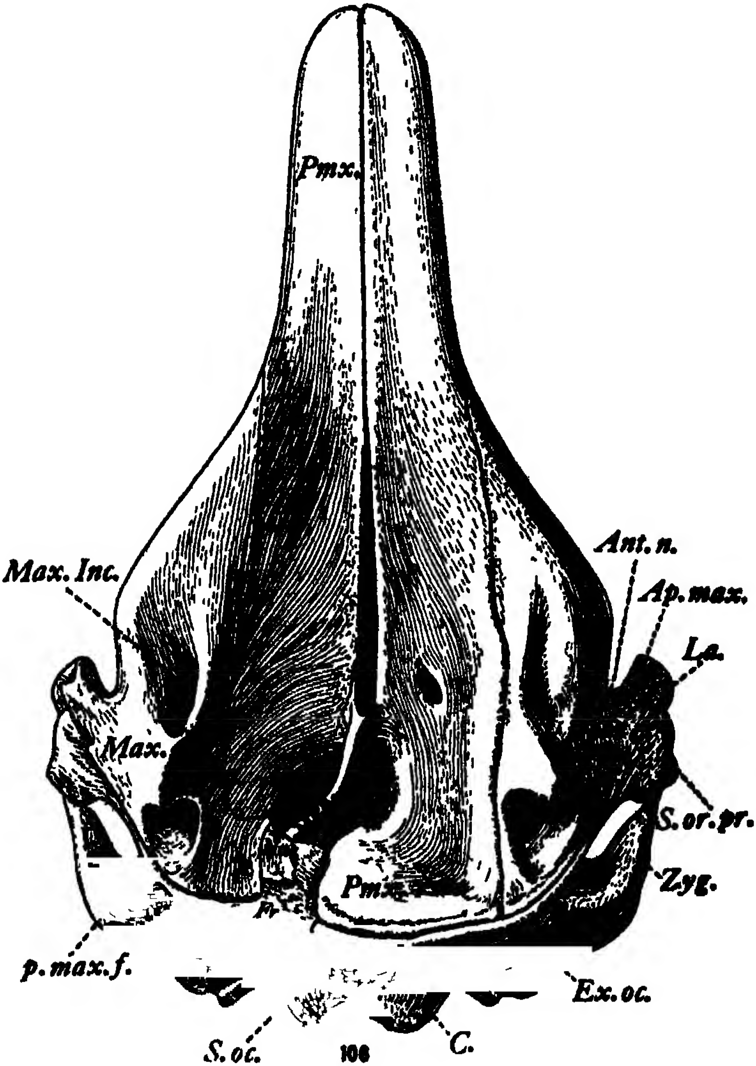


Fig 106 Dorsal view of skull of *Aulophyseter morricei*, restored, No 11230, U S N M, × ½

Measurements of Skull (in millimeters)

	No 11230, U S N M Adult	No 11313, U S N M Young
Total length, as preserved (condyles to tips of premaxillæ)	1114 0	
Total length, as estimated (condyles to tips of premaxillæ)	1210 0	
Length of rostrum, as preserved (antorbital notches to extremity)	712 0	
Total length of rostrum, as estimated (antorbital notches to extremity)	800 0	
Breadth of rostrum at antorbital notches, as restored	558 0[1]	354 0
Breadth of rostrum at swelling in front of antorbital notches, as restored	595 0[1]	360 0
Greatest breadth of skull across supraorbital processes, as restored	725 0[2] 748 0[3]	490 0
Greatest breadth of skull across zygomatic processes of squamosals	718 0	
Vertical height of skull (basioccipital to transverse crest)	298 0+	
Vertical height of skull (hamular process of pterygoid to transverse crest)	443 0+	
Vertical height of rostrum at base (at level of antorbital notches)	177 0	
Greatest width of right maxilla from a ventral view (inside margin to apophysis)	363 0	210 0
Greatest length of right premaxilla, as preserved	988 0	
Greatest breadth of right premaxilla at level of nares	121 0	82 0
Greatest breadth of right premaxilla posterior to nares	197 0	
Least breadth of right premaxilla in front of antorbital notches	113 0	74 +[4]
Greatest antero-posterior diameter of supraorbital process of right frontal at extremity	137 0	100 0[5]
Greatest thickness of preorbital portion of supraorbital process of right frontal	40 0	
Elevation of lateral crest of supracranial basin above orbit	250 0	
Least breadth of supraoccipital between temporal fossæ	480 0	
Distance from summit of transverse crest to upper margin of *foramen magnum*	133 +	
Height of *foramen magnum*	78 0	
Breadth of *foramen magnum*	95 0	

[1] Estimated [2] Anteriorly [3] Posteriorly [4] Inner border missing. [5] Left

Measurements of Skull (in millimeters)

	No 11230, U S N M Adult	No. 11313, U S. N M Young
Greatest distance between outside margins of occipital condyles	248 0	
Greatest vertical diameter of left condyle	158 0	
Greatest transverse diameter of left condyle	96 0	
Distance across skull between outer margins of exoccipitals	700 0	
Distance between anterior margin of apophysis of supraorbital process of right frontal and posterior margin of right condyle	493 0	
Distance across basicranium between *foramina ovale*	204 0	
Total length of vomer	780 0	
Greatest length of left palatine	238 0	
Greatest breadth of left palatine	135 0	
Greatest length of left pterygoid	293 0	
Greatest length of hamular process of right pterygoid	185 0	
Greatest transverse diameter of right lachrymal	198 0	151 0[5]
Greatest antero-posterior diameter of right lachrymal	75 0	68 5[5]
Greatest length of right jugal	107 0	62 +
Greatest length of right zygomatic process	198 0	
Greatest breadth of right alisphenoid at extremity	110 0	
Greatest depth of right alisphenoid at extremity	30 0	
Least distance between optic canal and *foramen ovale*	86 0	
Least distance between optic canal and jugulo-acoustic canal	162 0	
Greatest diameter of right respiratory passage	48 0	24 0
Greatest diameter of left respiratory passage	85 0	49 0

[5] Left.

TEETH

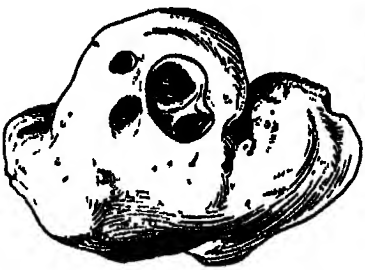
Crown covered with smooth enamel in front and on one side, but wrinkled on opposite side, enamel of crown passes into cement without any perceptible increase or decrease in diameter or neck, root long, backwardly curved, and broadly oval in cross section, pulp cavity closed

PERIOTIC

None of the periotic bones here discussed was attached to a skull, and were it not for the fact that only one type of physeteroid periotic was represented among the many specimens

obtained from a short trench dug in the uppermost horizon of the Temblor formation, there might be some question as to their allocation Eight right and three left periotic bones of this physeteroid were obtained at the one locality

It is remarkable how closely, except for minor modifications in the anterior process, these periotics resemble those of recent sperm whales, for the relative proportions and peculiarities of the various structures are essentially the same As in other



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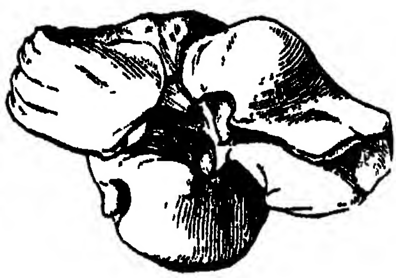


108

Right periotic of *Aulophyseter morricei*, No 2795, C. A S, × 0 75 Fig 107 Cerebral view Fig 108. Inferior view.

sperm whales, the periotic may be divided for purposes of description into a very dense external portion, the combined anterior and posterior processes, a lighter internal sub-hemispherical *pars cochlearis* and the *pars vestibularis* Minor variations in the contour of the articular facet on the posterior process are observable in the eleven periotics under consideration, but most of them may be attributed to the effects of erosion There are fine osseous crests on the tympanic face of the posterior process which are arranged like rays radiating from a common center on the internal margin This articular facet is irregular in outline, the posterior margin rather evenly curved, and the external and anterior margins more or less sinuous The major portion of the posterior facet is concave, but the anterior border slopes obliquely to the groove for the external auditory tube The ventro-internal border of this process projects inward and the free edge contributes the floor of the facial canal for approximately one-half of its length The external face of this process is flattened and more or less

rugose. According to the text figure and photographs the right and left periotics reproduced in the memoir by Abel,[87] and which are unfortunately allocated to *Eurhinodelphis longirostris*, it is evident that the distal or external portion of the posterior process is distinctly emarginate and rugose

There is very little variation in the general outlines of the *pars cochlearis* (fig 108), as seen from a ventral view, in these eight periotics Whatever differences are observable are of a minor nature There is a low, short crest or nodosity near the middle and on the internal border of the *pars cochlearis* on nine of these periotics, which may have resulted from contact with the involucrum of the tympanic The major portion of the ventral face of the *pars cochlearis* is more or less flattened and slopes toward the anterior margin, with the most inflated point opposite to the *fenestra ovalis* The external face is flattened and nearly vertical From a tympanic view, three apertures are visible, and, of these, the largest is the *fenestra rotunda* on the posterior face of the labyrinthic region This fenestra is crescentic in outline, with a rounded nodosity above which partially closes the opening The *fenestra ovalis* is ovoidal in outline and is situated near the center of the tympanic face of the periotic A narrow rim which is raised above the canal for the facial nerve and the fossa for the stapedial muscle encircles the fenestra on the outside The foot plate of the stapes completely fills the fenestra A medium sized internal passage, which leads from the vestibule, and a pair of minute antero-external foramina, leading to the semicircular canals also open into the vestibule The minute aqueduct leading from the *foramen singulare* opens near the bottom of the vestibule on the internal wall and near the anterior angle The epitympanic orifice of the *aquæductus Fallopii* and the *fenestra ovalis* lie in a depression, although the former is largely concealed from a ventral view by the projecting ledge of the *fossa incudis* Posterior to this orifice, the facial canal is open along its whole length, sloping obliquely downward and curving around the posterior face of the posterior process Posteriorly, the facial canal borders on a large semi-enclosed fossa for the stapedial muscle The fossa for the

[87] O Abel, Les dauphins longirostres du Boldérien (Miocène supérieur) des environs d'Anvers Mem. Mus Roy d'Hist Nat Belgique vol 2, 1902, pp. 121 123, text fig 19, pl 17, figs 11 12

stapedial muscle is a deep concavity and the surface for the attachment of the muscle extends downward upon the external face of the *pars cochlearis* A thin-edged crest is developed on the ventro-external angle of the labyrinthic region by the encroachment of the fossa for the stapedial muscle. This thin curved crest, which rises behind the stapedial fossa, has been destroyed on eight of these periotics, including that associated with the type skull, but is well preserved on three Between the *fenestra ovalis* and the deep concave fossa for the head of the malleus, there is a narrow crescentic excavation which commences near the epitympanic orifice of the *aquæductus Fallopii* and extends downward on the external face of the *pars cochlearis* to its tympanic face Between the rounded tuberosity or swelling on the anterior process and the anterior border of the articular facet on the posterior process, the ventral surface of the external denser portion of the periotic is hollowed out, becoming distinctly grooved as it approaches the *fossa incudis* On seven of these periotics the *fossa incudis* is preserved in its entirety, but it has been damaged on the periotic associated with the type skull This small shallow elliptical fossa is situated at the extremity of the thin ledge which projects inward below the facial canal. The *fossa incudis* receives the *crus breve* of the incus

The extremity of the anterior process resembles the handle end of a crutch when viewed from in front This peculiarity is produced by two projecting points, the external and internal angles. There is a crease, more distinct on some than on others, on the posterior face of the tuberosity external to the epitympanic orifice of the *aquæductus Fallopii* The external face of the anterior process is rounded off between this tuberosity and the apex of the process. Anterior to the fossa for the head of the malleus, the ventral surface of the anterior process is deeply concave from end to end and more or less flattened from side to side The relatively large accessory ossicle or unciform process of the tympanic is lodged in this fossa Accessory ossicles were present on all eleven of these periotics The accessory ossicle is relatively large, almost egg-shaped, with a longitudinal groove marking the line of ankylosis with the external lip of the tympanic, and fusing with the anterior process of the periotic along its posterior and

external margins If this ossicle is forcibly removed, small portions of the corresponding surface of the anterior process break away with it When the accessory ossicle is in position, it contributes the outer wall of the deep notch between it and the *pars cochlearis*

Most of the depressions and nodosities observed on the denser external portion of the cerebral face of the periotic do not appear to have any deep seated significance Four of these periotics have a rather prominent pyramidal tuberosity arising external to the orifice of the *aquæductus vestibuli* and three do not exhibit any trace of this nodosity. On two there is a large nodosity external to the entrance to the *aquæductus Fallopii* On all of these periotics a broad groove, irregular in appearance because of the presence of small nodosities, traverses the anterior process in front of the *pars cochlearis* From a cerebral view the posterior process appears rather slender and the anterior process very robust, the *pars cochlearis* is inclined forward An irregular crease defines the limits of the *pars vestibularis* and the posterior process on the cerebral face of the periotic The *pars vestibularis* is relatively small, its external surface is concealed by the anterior and posterior processes, and internally it is continuous with the *pars cochlearis*

A rather instructive example of how slight changes in the growth of a bony partition between the entrance to the *aquæductus Fallopii* and the more centrally placed *tractus spiralis foraminosus* can modify the contour of the internal acoustic meatus is shown in these eleven periotics The internal acoustic meatus of the periotic (fig 107) used for illustration represents the average type In the majority of these periotics the rim of the internal acoustic meatus is pyriform in outline In others a thin partition or transverse crest is interposed between the entrance to the *aquæductus Fallopii* and the fossa bounding the spiral tract The outer edge of this transverse crest is almost continuous with the rim of the meatus and imparts a distinctly ovoidal outline to the latter The largest and most external of the orifices which appear on the cerebral face is that of the *aquæductus Fallopii,* which pierces the substance of the periotic and through which passes the facial nerve to emerge on the tympanic face slightly anterior to the *fenestra ovalis.* Internal to the entrance to the *aquæductus Fallopii* is

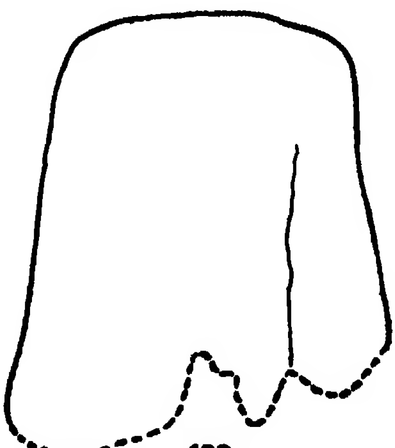
Measurements of Periotics (in millimeters)

	No. 11230, U S.N M Right (type)	No. 10853, U S.N M Right	No 2798 C A S Right	No. 2795 C A S. Right	No. 2794, C A. S Right	No. 2797, C A. S Right	No 2799 C A S Left	No 2800, C A S Right	No. 2801, C A S Right
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	25 2	26 0	25 1	28 5	25 0	27 8	26 1	27 0	23 1
Greatest length of periotic (tip of anterior process to tip of posterior process)	38 1	41 +	37 6+	42 0	36 2			42 5+	36 7+
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	21 0	19 5	19 0	17 0	16 8	19 7	17 5	21 3	17 9
Distance between *fenestra rotunda* and tip of anterior process	26 8	29 1	26 1	28 3	26 0	28 7	27 6	28 0	25 0
Distance between *fenestra rotunda* and tip of posterior process	19 +	22 9+	18 3	20 2	17 2			21 5	18 0
Distance between epitympanic orifice of *aquaeductus Fallopii* and tip of anterior process	18 8	21 5	20 0	21 5	19 1	21 2	19 4	20 7	18 7

the deep internal acoustic meatus, on the bottom of which is the *tractus spiralis foraminosus* and the minute *foramen centrale* On the external wall of this meatus and about half-way between the rim and the bottom is a small compressed *foramen singulare* A relatively thin partition or transverse crest, whose outer margin may or may not be depressed below the level of the rim of the internal acoustic meatus, places the orifice of the *aquæductus vestibuli* outside of and posterior to the meatus This orifice is compressed and opens into a slit-like fossa The cerebral orifice of the *aquæductus cochleæ* is considerably larger than that for the *aquæductus vestibuli*, and the interval between these orifices varies from 2 to 3 8 mm

Radius

Two radii that lack the distal end of the shaft are referred to this fossil sperm whale They correspond in shape with those of *Physeter catodon* and differ from those of all known cetotheres Each radius has a thin proximal epiphysis comprising the articular surface for the humerus This articular surface is rugged and is flush with the external or lateral margin, but slopes abruptly to the internal margin The hemi-



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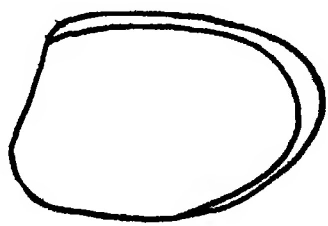
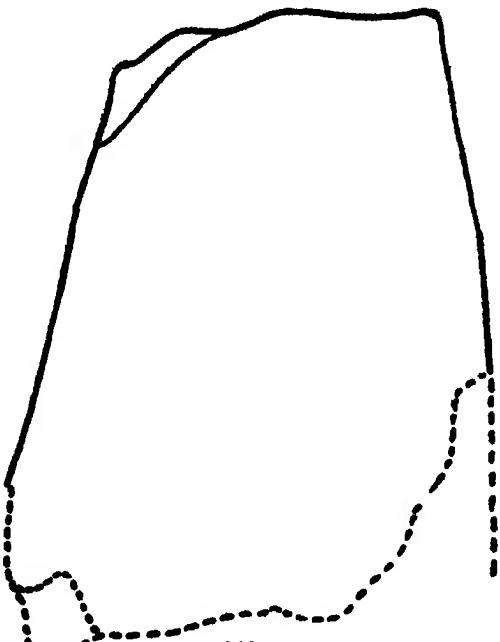


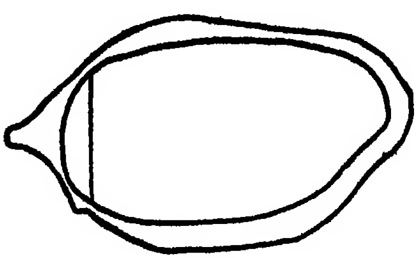
110

Proximal end of right radius of (?) *Aulophyseter morricei*, No. 4444, C. A. S., × 1 0 Fig 109 External view Fig 110 Proximal view

circular facet for the ulna at the proximal end of the posterior face is depressed mesially The shaft is flattened from side to side The facet for the humerus on the largest radius (No 4445, C A S) measures 74 4 mm antero-posteriorly and 54 mm transversely The same measurements for the smaller radius (No 4444, C A S) are 68 mm and 48 5 mm, respectively



111



112

Proximal end of right radius of (?) *Aulophyseter morricei*, No. 4445, C. A S, × 1.0. Fig 111 External view Fig 112 Proximal view

Family SQUALODONTIDÆ Shark-toothed Porpoises

The two ear bones hereinafter described are referred to the genus *Squalodon,* for reasons which are almost indefinable, and yet all known squalodonts have similar peculiarly shaped periotics The subtile characters that distinguish the periotics of squalodonts from those of other porpoises are apparent to

113 114

Left periotic of *Squalodon errabundus,* No 11573, U S N M, × 1.0
Fig 113 Inferior view Fig 114 Cerebral view.

anyone who has studied these bones, although it is difficult to point out any tangible feature which will invariably identify them This appears to be the first published occurrence of a representative of this family in Tertiary deposits on the Pacific Coast of North America Remains of squalodonts have been found in Australia and New Zealand

12. **Squalodon errabundus**[58] Kellogg, new species

Holotype Left periotic, No 11573, Division of Vertebrate Paleontology, U S Nat Mus. from **Sharktooth Hill, Kern County, California**; Temblor Miocene, Charles Morrice, Coll, 1924

Aside from the loss of the posterior process, the type periotic is exceptionally well preserved Both processes are broken off on a second left periotic (No 11574, U S N M) referred to this species Very little variation can be observed in corresponding parts of these two periotics

Diagnosis Viewed from the ventral side (fig 113) the *pars cochlearis* is convex, although it is depressed opposite the *fenestra ovalis,* and the posterior face slopes abruptly to the cerebral margin above the large *fenestra rotunda.* The narrow

[58] *Errabundus,* wanderer

external rim of the *fenestra ovalis* is not complete and is depressed below the channel for the facial nerve The epitympanic orifice of the aqueduct of Fallopius is relatively small A portion of the stapedial fossa and most of the groove for the facial nerve extend over upon the missing posterior process of the type periotic The fossa for the stapedial muscle is deep, rather small, and extends downward upon the outer wall of the *pars cochlearis*, it stops anteriorly at the narrow external rim of the *fenestra ovalis* A sharp-edged crest is developed on its internal margin It is possible that the second periotic may be abnormal in one respect, for the above mentioned sharp-edged crest, which forms the inner border of the stapedial fossa, is appressed posteriorly to the posterior process, forming an aqueduct through which the facial nerve passed in its outward course No recent or fossil porpoise, known to the writer, has a periotic modified in this manner The excavation on the outer denser portion of the periotic between the posterior process and the tuberosity is very narrow and deep The narrow projecting ledge, on which the *fossa incudis* is situated, is damaged on both periotics Between the pointed extremity and the constriction in front of the tuberosity, the anterior process swells out on the cerebral side, forming a large protuberance On the internal side of the narrow tuberosity is a large concavity for lodging the head of the malleus

Some of the distinguishing features of the periotic of this porpoise, as compared with that of *Squalodon calvertensis*,[89] are the position of the fossa inclosing the orifice of the *aquæductus vestibuli*, the shape of the anterior process, the relative size of the *pars cochlearis*, and the cucurbital outline of the internal acoustic meatus A low broad transverse crest (fig 114) separates the large entrance to the aqueduct of Fallopius from the more centrally placed fossa for the *tractus spiralis foraminosus* The *foramen centrale* pierces the transverse crest at its external angle Outside and external to the internal acoustic meatus is a deep fossa into which the aqueduct of the vestibule opens The small circular orifice of the cochlea is equally distant from the rim of the meatus The cerebral and external faces of the outer denser portion of the periotic form

[89] R Kellogg, Proc U S Nat Mus, vol. 62, publ 2462, 1923, text fig 3, and pl 8, fig 6

a continuous smooth convex surface, imparting the characteristic shape to this ear bone.

Measurements of Periotics (in millimeters)

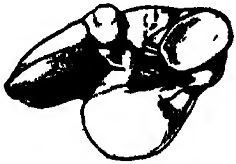
	No 11573, U S N M Left (type)	No 11574, U S N M Left
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	25 7	24 0
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	14 1	15 0
Distance between *fenestra rotunda* and tip of anterior process	28 0	..
Distance between epitympanic orifice of *aquæductus Fallopii* and tip of anterior process	23 8	

Family DELPHINIDÆ Porpoises

13 **Liolithax kernensis**[60] Kellogg, new genus and species

Holotype Left periotic, No 4340, Mus Calif Acad Sci., from **Sharktooth Hill, Kern County, California**; Temblor Miocene, Charles Morrice, Coll, 1924 *Paratype* No 11565, Division of Vertebrate Paleontology, U S Nat Mus

115



116

Left periotic of *Liolithax kernensis*, No 4340, C A S., × 1 0 Fig 115 Cerebral view. Fig 116 Inferior view.

[60] λειος, smooth, λιθαξ, diminutive of λιθος a small stone, in allusion to the dense periotic bone, *kernensis*, the Kern River region

Diagnosis Four left periotics are known for this species, two of which belong to the California Academy of Sciences and two to the United States National Museum One of the specimens in the California Academy of Sciences is imperfect and somewhat worn. In general, the periotic of this porpoise seems to be characterized by the direction of the facet on the ventral face of the posterior process, by the prolongation of the antero-ventral angle of the anterior process to support the outer lip of the bulla, by the transverse crease on the ventral surface of the anterior process which marks the anterior limit of the tuberosity, by the presence of a deep incisure on the posterior face above and internal to the stapedial fossa, and by the constriction of the entrance to the *aquæductus Fallopii*

The ventral facet of the posterior process is badly worn on all four of these periotics, but it is most nearly complete on the one here figured (fig 116) This facet slopes from the apex to the base and is shallowly concave, the ventro-internal margin is raised and the postero-internal angle overhangs the groove for the facial nerve The posterior and external faces of the posterior process form a continuous curve The *pars cochlearis* is relatively smaller than in *Platylithax robusta,* and externally it rises more abruptly from the *fenestra ovalis* The *fenestra rotunda* is circular in outline and produces a slight indentation, although the *pars cochlearis* is not noticeably inflated in the region of the aqueduct of the cochlea The rim of the *fenestra ovalis* is very narrow, but the raised border which separates it from the channel for the facial nerve, and the fossa for the stapedial muscle is rather broad Within the vestibule can be seen the small orifices of the semicircular canals and the terminal opening of the *foramen singulare* The epitympanic orifice of the *aquæductus Fallopii* is placed above the antero-internal angle of the fossa for the head of the malleus, and the channel for the facial nerve leading backward from it is sharply defined anteriorly, but posteriorly its margins become rather indistinct The fossa for the stapedial muscle encroaches internally upon the *pars cochlearis,* resulting in the formation of a crest posterior and external to the *fenestra rotunda*

The *fossa incudis* (fig 116) for the *crus breve* of the incus is very narrow and occupies a thin ledge Externally a thin carina separates this fossa from the excavation on the outer denser portion of the periotic between the posterior process and the tuberosity The anterior process is furnished with a pointed tongue-like process which projects inferiorly beyond the rounded extremity On three of these periotics the ventral surface of this pointed process is grooved longitudinally to provide additional support for the outer lip of the bulla. The accessory ossicle of the bulla rests on the ventral surface of the anterior process between the pointed extremity and the tuberosity at the base The concavity for lodging the head of the malleus has a slight indentation on its external border which is associated with the crease which marks the posterior limit of the tuberosity

The elongate internal acoustic meatus (fig 115) is the most prominent structure on the cerebral face This meatus is

Measurements of Periotics (in millimeters)

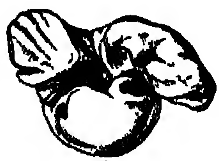
	No 10854, U S N M Left	No 4340, C A S Left (Holotype)	No 4341, C A S Left	No 11365, U S N M Left
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	18 2	20 2		19 7
Greatest length of periotic (tip of anterior process to tip of posterior process)	29 5+	31 8+	30 +	30 8+
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	13 3	12 8	12 0	12 8
Distance between *fenestra rotunda* and tip of anterior process	20 5	22 0		21 8
Distance between *fenestra rotunda* and tip of posterior process	12 5+	14 7+		14 2+
Distance between epitympanic orifice of *aquaeductus Fallopii* and tip of anterior process	17 2	18 5	16 8	18 0

strongly constricted along the entrance to the *aquæductus Fallopii*, and behind this constriction its walls descend obliquely to the kidney shaped fossa which is occupied by the *tractus spiralis foraminosus* A low partition separates this fossa from the entrance to the aqueduct of Fallopius On three of these periotics, the slit-like *foramen singulare* is situated on this transverse bony crest, but on the fourth (No 10854 U S N M) it is placed near the level of the spiral tract The cerebral orifice of the *aquæductus vestibuli* opens into a deep triangular fossa and the small circular orifice of the aqueduct of the cochlea is placed much closer to the rim of the internal acoustic meatus. The cerebral and external faces of the outer denser portion of the periotic form a continuously curved surface, without any irregularities The anterior process, as viewed from the cerebral side, is rather robust and convex.

14 **Œdolithax mira**[61] Kellogg, new genus and species

Holotype Right periotic, No 11572, Division of Vertebrate Paleontology, U S Nat Mus from **Sharktooth Hill, Kern County, California**, Temblor Miocene, Charles Morrice, Coll., 1924 *Paratype* Left periotic, No 11571, Division of Vertebrate Paleontology, U S Nat Mus

117



118

Right periotic of *Œdolithax mira*, No 11572, U S. N M , × 10 Fig 117 Cerebral view Fig 118 Inferior view

Diagnosis The periotics referred to this porpoise are in some respects larger replicas of those referred to *Lampfolithax simulans* Attention is directed to the pronounced inflation of the *pars cochlearis* posterior to the aqueduct of the cochlea, to the depression whose apex is formed by the fossa inclosing the orifice of the aqueduct of the vestibule and whose base is the

[61] οἰδέω, to swell, to become swollen, λιθαξ, diminutive of λιθος, a small stone in allusion to the dense periotic bone, *mira*, strange, wonderful.

outer rim of the internal acoustic meatus, to the rather deep pit on the posterior face above the stapedial fossa, and to the antero-posterior diameter of the *pars cochlearis*

The margins of the ventral facet on the posterior process (fig 118) of the type periotic are worn and the posterior half, at least, of this process is missing on the paratype periotic In so far as can be determined from these two specimens, this facet is concave on the basal half, rather wide, and is furnished with a few grooves radiating outward from the raised ventro-internal margin Viewed from the ventral side, the *pars cochlearis* is most strongly inflated in front of the *fenestra rotunda*, slightly depressed opposite the *fenestra ovalis*, and slopes toward the anterior and inner margins A low crest is also present on its antero-external border The *fenestra rotunda* is crescentic in outline and the surface is depressed behind it The outer narrow rim of the *fenestra ovalis* is incomplete and no carina intervenes between it and the more elevated channel for the facial nerve In the narrow vestibule are the usual orifices of the small semicircular canals The channel for the facial nerve, which leads backward from the epitympanic orifice of the *aquæductus Fallopii*, is rather broad and appears to terminate at the postero-internal angle of the posterior process The deep elongate fossa for the stapedial muscle extends forward to the narrow external rim of the *fenestra ovalis* and is bordered on the internal side by a sharp-edged crest

The *fossa incudis* is destroyed on the type periotic On the paratype periotic, the *fossa incudis* is rather small, elliptical in outline, and is raised above the rather narrow and deep excavation on the outer denser portion of the periotic The anterior process is robust and is bluntly truncated at the extremity On its ventral surface is the usual mesially elevated cordiform facet for the accessory ossicle of the bulla The posterior outline of the tuberosity is convex on both periotics, but the type differs from the paratype in having a deep transverse crease on the posterior face of the tuberosity and a corresponding notch in the fossa for the head of the malleus

Direct comparison of these two periotics with the six periotics referred to *Lamprolithax simulans* revealed some minor differences. The shape of the internal acoustic meatus varies

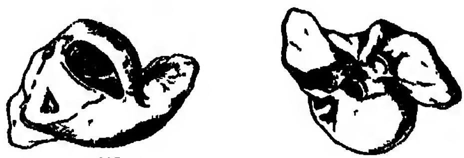
in both species. On the type periotic of *Œdolithax mira* (fig 117), the entrance to the aqueduct of Fallopius is constricted anteriorly, and, on the paratype, the opposing walls have grown together, but the minute aqueduct leading to the original entrance is still open The transverse crest extends more than half way to the outer rim of the meatus and posterior to it, but above the deep fossa for the *tractus spiralis foraminosus,* is the *foramen singulare* Behind the posterior angle of the internal acoustic meatus and on the posterior face of the *pars cochlearis* is the small cerebral orifice of the aqueduct of the cochlea The fossa inclosing the cerebral orifice of the aqueduct of the vestibule forms the apex of a triangular area which terminates at the outer rim of the internal acoustic meatus This area is more noticeably depressed on the paratype than on the type periotic The cerebral and external surfaces of the outer denser portion of the periotic are convex and the extero-ventral border of the anterior process over-rolls the external face

Measurements of Periotics (in millimeters)

	No 11572, U S N M Right, Type	No 11871, U S N M Left, Paratype
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	17 6	17 2
Greatest length of periotic (tip of anterior process to tip of posterior process)	29 6+	26 4+
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	9 9	11 1
Distance between *fenestra rotunda* and tip of anterior process	19 4	18 0
Distance between *fenestra rotunda* and tip of posterior process	14 5+	14 7+
Distance between epitympanic orifice of *aquaductus Fallopii* and tip of anterior process	14 9	14 0

15. Lamprolithax simulans[63] Kellogg, new genus and species

Holotype Right periotic, No 11566, Division of Vertebrate Paleontology, U S. Nat Mus, from **Sharktooth Hill, Kern County, California**; Temblor Miocene, Charles Morrice, Coll, 1924 *Paratype* No 11568, U S N M *Referred specimens*, No 11567, U S N M, and Nos 4344, 4345, 4346, Mus Calif Acad Sci



119 120

Right periotic of *Lamprolithax simulans*, No 11566, U S N M, × 10
Fig 119 Cerebral view Fig 120 Inferior view

Diagnosis Of the six periotics herewith listed, three are in the collection of the California Academy of Sciences and three in the United States National Museum Four of these periotics are from the right side and two from the left side Two of these six periotics have the apex of the depressed subtriangular area behind the internal acoustic meatus produced considerably beyond the fossa inclosing the cerebral orifice of the aqueduct of the vestibule This apex is foreshortened on the four remaining periotics From *Lamprolithax annectens* the periotic of this porpoise differs in having the apex of the triangular depressed area behind the internal acoustic meatus produced beyond the fossa which incloses the aqueduct of the vestibule, a smaller *pars cochlearis*, and a more sharply defined crest on the cerebral face of the anterior process

None of these periotics have the facet on the ventral face of the posterior process complete This series does show that the ventral facet is traversed by ridges radiating from the raised ventro-internal margin The posterior face of the posterior process is excavated and the external is obliquely truncated The remainder of the periotic, viewed from the ventral side (fig 120), resembles that of *Lampolithax annectens*

[63] λαμπρος, splendid, λιθαξ diminutive of λιθος a small stone, in allusion to the dense periotic bone, *simulans*, imitating

Considerable variation in the contour of the internal acoustic meatus may be expected in the periotics of this porpoise, judging from the differences observed in this small series. One (No 11567, U S N M) has a very narrow meatus and another (No 11568, U S N M) has the outer edge of the transverse bony crest separating the entrance to the aqueduct of Fallopius from the fossa for the spiral tract flush with the level of the rim of the meatus. Four, including the type periotic (fig 119), have a meatus with essentially the same out-

Measurements of Periotics (in millimeters)

	No 11566, U.S.N.M Right, Type	No 11567, U.S.N.M Right, Paratype	No 11568, U.S.N.M Left,	No. 4344, C.A.S Right,	No 4345, C.A.S. Right,	No 4346, C.A.S Left
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*	16 4	16 1	16 5	16 3	15 9	([1])
Greatest length of periotic (tip of anterior process to tip of posterior process)	26 3+	26 3+	([1])	25 5+	26 7+	([1])
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	9 6	9 6	9 3	10 0	8 9	
Distance between *fenestra rotunda* and tip of anterior process	17 2	17 4	17 8	17 3	17 0	17 8
Distance between *fenestra rotunda* and tip of posterior process	13 2+	13 2+	([1])	14 +	14 +	([1])
Distance between epitympanic orifice of *aquaeductus Fallopii* and tip of anterior process	13 3	13 5	14 6	13 8	13 3	13 9

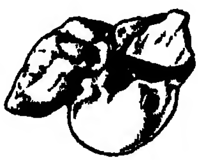
[1] Posterior process missing

line. The aqueduct of Fallopius and the *foramen singulare* also vary in size, and on two of these periotics they show an increase of two diameters over the smallest. The vestigial original entrance to the aqueduct of Fallopius in the notch between the anterior process and the *pars cochlearis* is open on two of these periotics In the others this small aqueduct has lost its connection with the functional aqueduct On five of these periotics the transverse bony crest rises about half way to the outer rim of the internal acoustic meatus and on the sixth, as mentioned above, it is flush with the outer rim On the last mentioned periotic, the *foramen singulare* is placed on the posterior face of the transverse crest about half way between the bottom of the fossa occupied by the spiral tract and the rim of the meatus. The five remaining periotics have the *foramen singulare* on the outer edge of the transverse crest at the same level and in approximately the same position as on the abnormal periotic. The fossa into which the aqueduct of the vestibule opens is rather large on five of these periotics and on the sixth it is nearly closed. The cerebral orifice of the aqueduct of the vestibule is situated on the posterior face of the *pars cochlearis* The cerebral face rolls over upon the external face of the outer denser portion of the periotic A small pit is present on the posterior face above the stapedial fossa

16 **Lamprolithax annectens**[43] Kellogg, new species

Holotype · Left periotic, No 4343, Mus Calif Acad Sci., from **Sharktooth Hill, Kern County, California**; Temblor Miocene, Charles Morrice, Coll., 1924. *Paratype* Left periotic, No 4342, Mus Calif Acad Sci.

121



122

Left periotic of *Lamprolithax annectens*, No 4343, C. A S, × 1 Fig. 121 Cerebral view Fig 122 Inferior view

[43] *annectens*, connecting

Diagnosis: One of the two periotics referred to this species lacks most of the posterior process The periotic of this dolphin has a rather broad internal acoustic meatus, a deep pit on the posterior face above the stapedial fossa, a low crest on the external margin of the ventral or tympanic face of the *pars cochlearis* opposite to the facet for the accessory ossicle, a raised crest on the internal margin of the deep stapedial fossa which projects backward beyond the *fenestra rotunda,* and a flattened area between the orifice of the *equæductus vestibuli* and the posterior rim of the internal acoustic meatus

The margins of the facet on the ventral face of the posterior process (fig 122) are eroded on the type periotic and the corresponding portion of the paratype periotic is lost. Ridges radiating outward from the ventro-internal margin traverse this facet The posterior face of the posterior process is excavated above this articular surface and the external face is flattened The ventral or tympanic face of the *pars cochlearis* is more or less flattened and is most strongly inflated immediately in front of the *fenestra rotunda*

The *pars cochlearis* swells out for a distance of 3 mm behind the kidney-shaped *fenestra rotunda,* but is depressed below the crest which bounds the stapedial fossa on the internal side The *fenestra ovalis* does not have a complete external rim and the groove for the facial nerve does not sink below the level of the latter as it does on the periotic of *Liolithax kernensis* The minute orifices of the semicircular canals are located within the vestibule in their usual position The groove for the facial nerve leading backward from the epitympanic orifice of the *aquæductus Fallopii* terminates at the postero-internal angle of the posterior process The fossa for the stapedial muscle is deep and elongate

The narrow *fossa incudis* is placed on a thin projecting ledge which lies below the level of the triangular excavation on the outter denser portion of the periotic between the posterior process and the tuberosity

The anterior process is directed obiquely forward and inward, compressed from side to side, and bluntly truncated or rounded at the extremity The cordiform articular surface for the accessory ossicle is bisected by a longitudinal elevation which follows the angle formed by the ventral and internal

faces of the anterior process On the internal face of the tuberosity is the deep concavity for lodging the head of the malleus

The cerebral face of this periotic (fig. 121) is characterized by some well marked features The external margin of the large internal acoustic meatus is nearly straight and the internal margin is curved Within this meatus are located the relatively large entrance to the *aquæductus Fallopii* and the deep fossa for the spiral tract Some 3 mm in front of the internal acoustic meatus is a small pit which is a remnant of a former entrance to the aqueduct of Fallopius A broad transverse crest, which rises about half way to the outer rim of the meatus, separates the entrance to the aqueduct of Fallopius from the *tractus spiralis foraminosus* The small *foramen singulare* is situated on the outer edge of this bony partition Behind the rim of the internal acoustic meatus is a rather large flattened triangular area having its apex formed by the fossa which surrounds the cerebral orifice of the aqueduct of the vestibule The small aqueduct of the cochlea has its cere-

Measurements of Periotics (in millimeters)

	No 4343, C A S Left, Type	No 4342, C A S Left
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	18 0	17 5
Greatest length of periotic (tip of anterior process to tip of posterior process)	27 9+	([1])
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	10 2	10 7
Distance between *fenestra rotunda* and tip of anterior process	19 1	18.9
Distance between *fenestra rotunda* and tip of posterior process	12 6+	([1])
Distance between epitympanic orifice of *aquæductus Fallopii* and tip of anterior process	14 8	14 5

[1] Posterior process missing

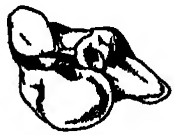
bral orifice on the posterior face of the *pars cochlearis* behind the postero-internal angle of the internal acoustic meatus. The external face is considerably broader than the cerebral face of the outer denser portion of the periotic On the cerebral face of the anterior process is a longitudinal crest.

17 Nannolithax gracilis[64] Kellogg, new genus and species

Holotype. Right periotic, No. 11569, Division of Vertebrate Paleontology, U. S. Nat. Mus

Diagnosis Two periotics of this porpoise have been collected, one of which lacks most of the *pars cochlearis,* and the exact relationships of the species to those heretofore described remains to be determined They do resemble some small periotics from the "molasse" of Baltringen near Biberach, in Württemberg, described and figured by Probst[65]

123



124

Right periotic of *Nannolithax gracilis,* No 11569, U S N M, × 1 Fig 123 Cerebral view Fig 124 Inferior view

Unlike the periotic of *Grypolithax obscurus,* which bears a general resemblance to it, this diminutive ear bone is decidedly angular and the anterior process is strongly compressed from side to side distally Some of the more important characters of this periotic are the compressed outline of the internal acoustic meatus, the attenuation of the anterior process, the relatively large size of the epitympanic orifice of the *aquæductus Fallopii,* and the absence of a pit on the posterior face above the stapedial fossa

The ventral facet on the posterior process of the type periotic (fig 124) is worn smooth, but fortunately that area is

[64] *νάννος,* dwarf, Λιθαξ, diminutive of λίθος, a small stone, in allusion to the dense periotic bone, *gracilis,* slender

[65] J Probst, Ueber die Ohrenknochen fossiler Cetodonten aus der Molasse von Baltringen O A. Laupheim. Jahreshefte d Ver f vaterl. Naturk. Württ., 1886, pp. 51 52, pl. 2, figs. 12-15

fairly well preserved on the second periotic. This articular surface is subtriangular in outline, concave in a fore and aft direction, and its raised ventro-internal margin overhangs the channel for the facial nerve The posterior face of the posterior process is flattened and the external is convex The ventral surface of the *pars cochlearis* is convex and slopes in an antero-internal direction The *fenestra rotunda* is large, circular in outline, and does not modify the posterior outline of the *pars cochlearis* to any appreciable extent The external narrow rim of the *fenestra ovalis* is indistinct The deep vestibule is provided with the usual orifices for the small semicircular canals A low carina separates the groove for the facial nerve from the *fenestra ovalis* anteriorly and the stapedial fossa posteriorly The groove for the facial nerve is rather broad and terminates at the postero-internal angle of the posterior process The elongate fossa for the stapedial muscle ends anteriorly at the outer rim of the *fenestra ovalis*, laterally it extends downward upon the external face of the *pars cochlearis* and the internal face of the posterior process, and is also bounded on the internal side by a low crest

The anterior and posterior halves of the *fossa incudis* meet at an obtuse angle mesially Anteriorly this fossa occupies a narrow projecting ledge, and, posteriorly, on the antero-internal margin of the posterior process, it expands into a somewhat broader and deeper pit In front of the abruptly truncated anterior face of the posterior process, the surface of the excavation on the outer denser portion of the periotic rises gradually to the crest of the tuberosity and is shut off internally from the epitympanic recess by the raised margin of the *fossa incudis* The anterior process is attenuated, strongly compressed from side to side distally, and its ventral surface is furnished with a mesially elevated cordiform articular surface for the accessory ossicle of the bulla. On the internal face of the crest-like tuberosity is a rather large concavity for lodging the head of the malleus

Within the narrow internal acoustic meatus (fig 123) is a low transverse crest which separates the compressed entrance to the aqueduct of Fallopius from the fossa occupied by the *tractus spiralis foraminosus* On the outer edge of the transverse crest and at the postero-external angle is the rather large

foramen singulare. The external, denser portion of the periotic presents a two-sided, flattened cerebral surface, the inner one of which borders the internal acoustic meatus and the outer overrolls the external face. The aqueduct of the vestibule opens into a deep fossa and the aqueduct of the cochlea terminates below the level of the cerebral face. The external face of the anterior process is flattened and the cerebral face is rounded.

Measurements of Periotics (in millimeters)

	No. 11569, U. S. N. M. Right, Type	No. 11570, U. S. N. M. Left
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	14.2	([1])
Greatest length of periotic (tip of anterior process to tip of posterior process)	23.8+	22.+
Greatest dorso ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	8.8	
Distance between *fenestra rotunda* and tip of anterior process	16.8	16.3
Distance between *fenestra rotunda* and tip of posterior process	11.7+	10.4+
Distance between epitympanic orifice of *aquaeductus Fallopii* and tip of anterior process	12.5	12.8

[1] *Pars cochlearis* damaged.

18. Platylithax robusta[80] Kellogg, new genus and species

Holotype. Right periotic, No. 4339, Mus. Calif. Acad. Sci., from **Sharktooth Hill, Kern County, California**; Temblor Miocene, Charles Morrice, Coll., 1924.

Diagnosis. Upon comparing this fossil periotic with those of living porpoises it was found that the periotic of *Delphinus delphis* exhibits the closest approach in general size and shape. This fossil periotic is characterized by a flattened and de-

[80] πλατυς broad, flat, λιθαξ diminutive of λιθος, a small stone, in allusion to the dense periotic bone. *robusta*, robust.

pressed area external to the internal acoustic meatus, by having the cerebral and external faces nearly at right angles to each other, and by the swelling behind the cerebral orifice of the cochlea

The margins of the facet on the ventral face of the posterior process (fig 126) for the corresponding process on the bulla are eroded, but it is apparent that it was originally smaller

125

126

Right periotic of *Platylithax robusta*, No 4339, C A S, X 1 0 Fig 125 Cerebral view Fig 126 Inferior view

than the corresponding facet on the periotic of *Delphinus delphis* The ventro-internal margin of the posterior process is raised, the posterior face is flattened, and the external face is rounded The *pars cochlearis* is rather large, convex, slightly inflated, and externally the surface slopes gradually to the *fenestra ovalis* The *fenestra rotunda* is relatively small, hemi-circular in outline, and is placed on a line with the anterior margin of the stapedial fossa The *fenestra ovalis* is encircled by a narrow rim which is depressed below the raised margins of the facial canal and the stapedial fossa Within the vestibule are the usual openings of the semicircular canals The epitympanic orifice of the *aquæductus Fallopii* is placed on a line with the anterior margin of the *fenestra ovalis,* and the canal for the facial nerve leading backward from it is partially concealed by the *fossa incudis* and the ventro-internal margin of the posterior process The fossa for the stapedial muscle is about as wide as the *fenestra rotunda* and extends downward upon the external face of the *pars cochlearis.*

The *fossa incudis* occupies the narrow ledge between the antero-internal angle of the posterior process and the epitympanic orifice of the *aquæductus Fallopii* The robust anterior process is flattened externally and rounded at the extremity The ventral face of the anterior process is furnished with a

large articular surface for the accessory ossicle of the bulla as well as the usual concavity for lodging the head of the malleus. The excavation between the posterior process and the tuberosity at the base of the anterior process is shut off from the epitympanic recess by the *fossa incudis*.

Viewed from the cerebral side (fig 125), this periotic presents a compressed internal acoustic meatus, a robust anterior process, and a flattened surface external to the acoustic meatus. The spiral tract and the foramen singulare are placed at the bottom of the internal acoustic meatus, and they are separated from the entrance to the *aquæductus Fallopii* by a low transverse crest The cerebral orifice of the *aquæductus vestibuli* is compressed and is separated by an interval of 3.6 mm from the rim of the internal acoustic meatus Behind the minute cerebral orifice of the aqueduct of the cochlea is a sub-conical swelling

Measurements of the right periotic

Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*) .	18.9 mm.
Greatest length of periotic (tip of anterior process to tip of posterior process) .	30 +mm
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	12.6 mm
Distance between *fenestra rotunda* and tip of anterior process	20.0 mm
Distance between *fenestra rotunda* and tip of posterior process .	15.5+mm.
Distance between epitympanic orifice of *aquæductus Fallopii* and tip of anterior process	16.3 mm

19. **Loxolithax sinuosa**[67] Kellogg, new genus and species

Holotype. Left periotic, No. 4352. *Paratype* Left periotic, No. 4351, Mus. Calif Acad. Sci. from **Sharktooth Hill, Kern County, California**; Temblor Miocene, Charles Morrice, Coll., 1924.

[67] λοξος, slanting, λιθαξ, diminutive of λιθος, a small stone, in allusion to the dense periotic bone, *sinuosa*, sinuous.

Diagnosis: Superficially these periotics bear a rather close resemblance to the periotic of *Grypolithax pavida*. They are remarkable for the angularity of their processes. The periotic of this porpoise has a broad facet on the ventral face of the posterior process, a relatively wide *fossa incudis*, an elongated internal acoustic meatus, a large fossa surrounding the cerebral orifice of the aqueduct of the vestibule, and an anterior process with a laterally compressed extremity.

127 128

Left periotic of *Loxolithax sinuosa*, No. 4352, C. A. S., × 1.0. Fig. 127. Cerebral view. Fig. 128. Inferior view.

129 130

Left periotic of *Loxolithax sinuosa*, No. 4351, C. A. S. × 1.0. Fig. 129. Cerebral view. Fig. 130. Inferior view.

Since the posterior process of the paratype periotic (fig. 130) has a much eroded ventral articular facet, the description of this structure will be based upon the type periotic (fig. 128). The ventral facet of the latter is exceptionally well preserved, the internal and posterior margins are nearly straight, but the anterior and external margins form a continuous curve. The articular surface slopes toward the diagonal depression extending from the apex to the antero-internal angle. The ventro-internal margin of the posterior process is raised and contributes the floor for the groove which lodges the facial nerve in that region. The posterior face of the posterior process is concave and the external is convex. The *pars cochlearis*, viewed from the ventral side, is convex with a shallow depres-

sion opposite the *fenestra ovalis*. Behind the *fenestra rotunda* the posterior surface of the *pars cochlearis* slopes to the cerebral margin. The elliptical *fenestra ovalis* is completely encircled by a narrow rim, and the whole structure is depressed below the groove for the facial nerve. The vestibule is deepest between the minute orifices of the semicircular canals. The fossa for the stapedial muscle is relatively deep and is bordered on the internal side by a sharp-edged crest. A slit-like depression is present on the posterior face above the stapedial fossa. The rather large *fossa incudis* occupies the thin ledge forming the lower boundary of the channel for the facial nerve in the region between the antero-internal angle of the ventral facet of the posterior process and the epitympanic orifice of the *aquæductus Fallopii*. The inner and outer margins of the *fossa incudis* are raised. The excavation between the posterior process and the tuberosity on the outer denser portion of the periotic is rather narrow and deep. The accessory ossicle of the bulla articulates with the anterior process on a cordiform facet, unevenly bisected by a longitudinal elevation. The distal end of the anterior process is compressed from side to side and the extremity is irregularly rounded. The tuberosity has a rounded posterior face, and the internal face bears the usual concavity for lodging the head of the malleus.

Viewed from the cerebral side (figs. 127, 129), the most obvious peculiarities are the side to side compression of the anterior process, the degree of concavity of the posterior face of the posterior process, the inflation of the *pars cochlearis* posterior to the aqueduct of the cochlea, and the shape of the internal acoustic meatus. The internal outline of the *pars cochlearis* is regularly curved. On the paratype periotic (fig. 129) the transverse crest separating the entrance to the aqueduct of Fallopius from the fossa occupied by the *tractus spiralis foraminosus* attains the level of the inner rim of the internal acoustic meatus, but it is depressed below the level of the latter externally. The *foramen singulare* pierces the external wall of the acoustic meatus above the level of the spiral tract. The type periotic has a much lower transverse crest, and the *foramen singulare* is placed on the outer edge of the latter. The entrance to the aqueduct of Fallopius is large and retains its connection with the groove which marks its original

course, although the latter is much reduced in size A relatively broad interval separates the triangular fossa into which the aqueduct of the vestibule opens from the rim of the internal acoustic meatus The small cerebral orifice of the aqueduct of the cochlea is placed on the posterior face of the *pars cochlearis* behind a tuberosity which has been developed at the posterior angle of the rim of the internal acoustic meatus

Measurements of Periotics (in millimeters)

	No 4352, C A S Left Type	No 4351 C A S. Left Paratype
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	16 8	16 3
Greatest length of periotic (tip of anterior process to tip of posterior process)	29 6+	28 0 28 +
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	10 0	10 5
Distance between *fenestra rotunda* and tip of anterior process	18 1	17 8
Distance between *fenestra rotunda* and tip of posterior process	15 8+	14 9+
Distance between epitympanic orifice of *aquaeductus Fallopii* and tip of anterior process	14 2	14 2

20 Grypolithax obscura[68] Kellogg, new genus and species

Holotype Right periotic, No. 4349 *Paratype* Left periotic, No 4347, Mus. Calif Acad Sci. from **Sharktooth Hill, Kern County, California**; Temblor Miocene, Charles Morrice, Coll , 1924

Diagnosis Five periotics are referred to this genus, four of which are from the left side and one from the right side It is not improbable that future discoveries will show that two genera are included in this small series of periotics, for the

[68] *γρυπος*, curved, *λιθαξ*, diminutive of *λιθος*, a small stone, in allusion to the dense periotic bone; *obscura*, obscure or unknown

two referred to *Grypolithax obscura* present a quite different contour from the three referred to *Grypolithax pavida*. For the present and in the absence of specific information in regard to cranial peculiarities, all of these periotic bones will be referred tentatively to this genus. The contours of the two periotics referred to this species are more rounded and less angular than those heretofore or hereinafter described, the pyriform internal acoustic meatus is strongly constricted anteriorly, the excavation on the outer denser portion of the periotic between the posterior process and the tuberosity is very narrow internally where it is shut off from the epitympanic recess by the *fossa incudis*, and the *pars cochlearis* is expanded behind the level of the aqueduct of the cochlea

131

132

Right periotic of *Grypolithax obscura*, No 4349, C. A S, × 1 0 Fig 131 Cerebral view Fig 132 Inferior view

The postero-external angle or apex of the posterior process (fig 132) is missing on the type periotic. Most of the outwardly projecting apex of this process is preserved on the paratype periotic (No 4347, C A S.). In its original condition the ventral facet on the posterior process was no doubt longer than wide, shallowly concave at the base, and bounded by raised ventro-internal and anterior margins The posterior and external faces of the posterior process above this facet are convex. The ventral or tympanic face of the *pars cochlearis* is convex and rises rather abruptly from the *fenestra ovalis*

The *fenestra rotunda* is larger than the *fenestra ovalis* and produces an indentation on the posterior face of the *pars cochlearis* The narrow external rim of the *fenestra ovalis* is complete Within the shallow vestibule can be seen the minute orifices of the semicircular canals. The epitympanic orifice of the aqueduct of Fallopius is small, and the groove leading backward from it for the facial nerve does not sink below the level of the rim of the *fenestra ovalis* and is separated from

the latter by a low carina. The fossa for the stapedial muscle is elongate and encroaches anteriorly upon the rim of the *fenestra ovalis,* and internally upon the outer wall of the *pars cochlearis.* A sharp-edged crest bounds this fossa internally. There is a depression but no pit on the posterior face above the stapedial fossa as in *Grypolithax pavida*

The *fossa incudis* is small and is bounded externally by a short carina The posterior wall of the excavation on the outer denser portion of the periotic between the posterior process and the tuberosity rises more abruptly than the anterior wall The anterior process is rather robust, attenuated, and roughly three-sided on the distal third, and is furnished with a nipple-like tuberosity on the extremity The articular surface for the accessory ossicle of the bulla is elongated and rather deeply impressed

From a cerebral view the *pars cochlearis* (fig 131) is seen to be not as strongly arched as in *Lamprolithax simulans,* the surfaces of the outer denser portion of the periotic are more rounded, the entrance to the aqueduct of Fallopius is strongly

Measurements of Periotics (in millimeters)

	No 4349, C. A S. Right Type	No. 4347, C A S. Left Paratype
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	16 4	17 2
Greatest length of periotic (tip of anterior process to tip of posterior process)	27 1+	28 7+
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	11 2	11 9
Distance between *fenestra rotunda* and tip of anterior process . .	17 0	19 0
Distance between *fenestra rotunda* and tip of posterior process	13 2+	15 4+
Distance between epitympanic orifice of *aquaeductus Fallopii* and tip of anterior process	13 9	15 2

compressed, and the internal face of the anterior process is creased The internal acoustic meatus is narrowly pyriform in outline, rather deep, and incloses a reniform fossa which is occupied by the spiral tract The transverse crest is low, rather broad, and is pierced at the postero-external angle by the small *foramen singulare.* The fossa which incloses the cerebral orifice of the aqueduct of the vestibule is narrow and rather deep, and near it in the usual position is the corresponding orifice of the aqueduct of the cochlea The *pars cochlearis* swells out behind the level of these orifices

21 **Grypolithax pavida** Kellogg, new species

Holotype Left periotic, No 4348. *Paratypes.* No 4350, Mus Calif Acad Sci, and No 11575, Division of Vertebrate Paleontology, U. S. Nat Mus, from **Sharktooth Hill, Kern County, California**; Temblor Miocene, Charles Morrice, Coll, 1924

133 134

Left periotic of *Grypolithax pavida,* No 4348, C A S, × 1 0 Fig 133 Cerebral view Fig 134 Inferior view

Diagnosis On direct comparison, the periotics of this porpoise as a rule are separable from those of *Grypolithax obscura* by the presence of an irregularly flattened area on the cerebral face of the outer denser portion of the periotic, a broader excavation between the posterior process and the tuberosity, a low crest on the antero-external border of the ventral face of the *pars cochlearis,* and a more rounded extremity of the anterior process

It seems unnecessary to give a detailed description of the periotic of this porpoise inasmuch as most of it would be merely a repetition of the preceding description. Attention is directed to the presence of a slit-like pit on the posterior face above the stapedial fossa on two of these periotics (Nos 4348,

4350, C A S.), but on the third (No 11575, U S N M) it is barely discernible The posterior and external faces of the posterior process immediately above the ventral facet are shelving The inflation of the *pars cochlearis* posteriorly is accentuated by a short crease which commences at the inner angle of the crescentic *fenestra rotunda* and proceeds inward in the general direction of the aqueduct of the cochlea The articular surface (fig 134) for the accessory ossicle of the bulla is subcordiform in outline, with a medial longitudinal elevation Opposite this facet and on the ventral face of the *pars cochlearis* is a low crest which is quite distinct on two of these periotics (Nos 4348, C A S, and 11575, U S N M), but is rather indistinct on the third (No 4350, C A S) On the type periotic (fig 133), the closure of the opposing walls of the original entrance to the aqueduct of Fallopius has been completed, leaving a minute orifice on the anterior margin of the *pars cochlearis* The two remaining periotics illustrate the manner in which this closure has been accomplished

Measurements of Periotics (in millimeters)

	No 4348, C A S Left Type	No 4350, C A S Left Paratype	No 11575 U S N M Left Paratype
Breadth of periotic at level of *fenestra ovalis* (from external face above excavation to internal face of *pars cochlearis*)	16 2	16 4	16 5
Greatest length of periotic (tip of anterior process to tip of posterior process)	26 9	26 5	26 6
Greatest dorso-ventral depth of periotic (from most inflated portion of tympanic face of *pars cochlearis* and external excavation to most projecting point on cerebral face)	9 7	9 9	10 4
Distance between *fenestra rotunda* and tip of anterior process	17 9	16 9	17 3
Distance between *fenestra rotunda* and tip of posterior process	13 9+	14 6+	13 9+
Distance between epitympanic orifice of *aquæductus Fallopii* and tip of anterior process	14 5	13 7	13 1

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XIX, No. 13, pp 399-410 MAY 29, 1931

XIII

REPORT OF THE PRESIDENT OF THE ACADEMY FOR THE YEAR 1930

BY

C E GRUNSKY

President of the Academy

Following the usual practice, attention will first be directed in this report to the Academy's membership There has been but little change in the total, despite the fact that a special effort brought in about 150 new members

The members are classified as follows

Patrons	19
Honorary Members	15
Life Members	94
Fellows	63
Members	923
Junior Members	10
Total	1124

Of these.

7 Life Members are also Fellows	7	
4 Patrons are also Life Members	4	
1 Fellow is also an Honorary Member	1	
3 Fellows are also Patrons	3	
1 Patron is not a member	1	
Total		16
Actual Membership		1108

On January 1, 1930, the number of members stood at			1086
New Members were added during the year		150	
Members lost by death	27		
Members resigned	43		
Members dropped (non-payment of dues)	58		
	—	128	
Net gain during year			22
Leaving the membership on January 1, 1931, at			1108

The Academy carries on its list of benefactors the following names

Deceased

Mr James Lick
Mr Ignatz Steinhart

The Academy carries on its list of patrons the following names

Living

Mr George C Beckley
Dr Frank E Blaisdell
Mr William B Bourn
Hon William H Crocker
Mr Peter F Dunne
Miss Alice Eastwood
Dr Barton Warren Evermann
Mr Herbert Fleishhacker
Hon Joseph D Grant
Mr Edward Hohfeld
Mrs Albert Koebele
Mr A Kingsley Macomber
Mr John W Mailliard
Mr Joseph Mailliard
Mr M Hall McAllister
Mr G Frean Morcom
Mr William C Van Antwerp
Mr Edward P Van Duzee
Dr E C Van Dyke

Deceased

Mr William Alvord
Mr Charles Crocker
Mr W M Giffard
Mr John W Hendrie
Mr William F Herrin
Mr Henry M Holbrook
Mrs Charlotte Hosmer
Mr Ogden Mills
Mr Alexander F Morrison
Mr Amariah Pierce
Dr John Van Denburgh

Academy members who were called by death in 1930 are as follows.

Dr Thomas Addison	Member	April 5, 1930
Mr. Harry Babcock	Member	February 24, 1930
Mr Robert C Bolton	Member	August 25, 1930
Mr Elisha Brooks	Life Member	May 11, 1930
Mr James F Campbell	Member	January 3, 1930
Mr Warren D Clark	Member	May 9, 1930
Prof John N Cobb	Member	January 13, 1930
Dr Lawrence A Draper	Member	January 3, 1930
Mr A L Duncan	Member	August 19, 1930
Col George C Edwards	Life Member	November 19, 1930
Mr A W Foster	Member	October 14, 1930
Mr Wm J Gilliland	Member	November 30, 1929
Mr William Herrmann	Member	September 30, 1930
Mr Leonard Howarth	Member	May 12, 1930
Mr W B Lewis	Member	August 26, 1930
Mr A S Mangrum	Member	September 3, 1930
Mr Stephen T Mather	Member	January 22, 1930
Dr William D Matthew	Member	September 24, 1930
Mr Robert S Moore	Member	February 16, 1930
Mr John Partridge	Member	August 14, 1930
Capt Albert H Payson	Member	January 25, 1930
Hon James D Phelan	Life Member	August 7, 1930
Mr G P Rixford	Life Member	October 27, 1930
Mr J H Skinner	Member	June 12, 1930
Mr William H Talbot	Member	November 5, 1930
Mr John I Walter	Member	March 5, 1930
Dr Lucy M F Wanzer	Life Member	October 20, 1930

In the year 1930, eleven free lectures were delivered at the stated meetings of the Academy, as follows:

JANUARY 2 — "The Horsetown Formation of California" By Mr Frank M Anderson, Honorary Curator, Department of Paleontology, California Academy of Sciences.

MARCH 5 — "A Sub-arctic Summer" Illustrated By Mr Harry S Swarth, Curator, Department of Ornithology and Mammalogy, California Academy of Sciences

APRIL 2 — "A Visit to the Desert and Forests of Australia" Illustrated with motion pictures By Mr Joseph R Slevin, Curator, Department of Herpetology, California Academy of Sciences.

MAY 7 "A Panamanian Pasear" Illustrated. By Mrs. M E McLellan Davidson, Assistant Curator, Department of Ornithology and Mammalogy, California Academy of Sciences

JUNE 4 "Bird Banding" By Mr Joseph Mailliard, Curator Emeritus, Department of Ornithology and Mammalogy, California Academy of Sciences

JULY 2 "Flags" Illustrated. By Mr C B Lastreto, San Francisco

AUGUST 6 "The Proposed Salt Water Barrier in the Upper Bay Waters" By Dr C E Grunsky, President, California Academy of Sciences

SEPTEMBER 3 "Floral Zones of the California Deserts" Illustrated By Mr John Thomas Howell, Assistant, Department of Botany, California Academy of Sciences

OCTOBER 1 "Seventh International Ornithological Congress, Amsterdam" By Mr Harry S Swarth, Curator, Department of Ornithology and Mammalogy, California Academy of Sciences

NOVEMBER 5 "Our South Sea Islands" Illustrated by motion pictures and stereopticon slides By Mr Alvin Seale, Superintendent of the Steinhart Aquarium of the California Academy of Sciences

DECEMBER 3 "A Report on My Trip to the International Botanical Congress" Illustrated By Miss Alice Eastwood, Curator, Department of Botany, California Academy of Sciences

The Sunday afternoon lectures at the Museum building were continued throughout the year except during the vacation months of summer Despite the inadequacy of the temporary lecture room, the attendance at these lectures has been satisfactory These lectures have included the following

JANUARY 5 "With a Moving Picture Camera in Africa" Illustrated By Dr E C Franklin, Professor of Organic Chemistry, Stanford University

JANUARY 12 "East Winds" By Mr E A Beals, Consulting Meteorologist, Alameda, California

JANUARY 19. "Aviation and Meteorology" Illustrated By Mr D. R Reed, Assistant Forecaster, United States Weather Bureau, San Francisco

JANUARY 26	"The Climate of the Pacific Northwest" By Mr. Melvin B Summers, in charge of the Seattle Weather Bureau and Climatological Service of the State of Washington. At present with the San Francisco office
FEBRUARY 2	"Indians of Yosemite and Their Legends" Illustrated By Mr Ansel F Hall, Chief Naturalist, National Park Service
FEBRUARY 9	"Geology of the Lassen Region" Illustrated By Mr Harold Stein, Field Executive, Boy Scouts of America, San Francisco
FEBRUARY 16	"Personal Experiences with Black and Grizzly Bears" Illustrated By Mr Joseph Dixon, Economic Mammalogist, University of California, Berkeley
FEBRUARY 23	"Prehistoric Peoples of the Southwest" Illustrated By Mr Ansel F Hall, Chief Naturalist, National Park Service
MARCH 2	"An Engineer's Trip to Japan and Adjacent Countries" By Dr C E Grunsky, President of the California Academy of Sciences
MARCH 9	"Desert Insects" Illustrated By Dr E C Van Dyke, Curator Emeritus, Department of Entomology, California Academy of Sciences
MARCH 16	"Some Problems in Game Conservation" Illustrated with motion pictures By Dr H C Bryant, Director, Bureau of Education, California Division of Fish and Game
MARCH 23	"The Amphibians of California" Illustrated By Dr Tracy I Storer, Associate Professor of Zoology, University of California, College of Agriculture, Davis, California
MARCH 30	"Game Trails, Steelhead Fishing on the Klamath" Illustrated By Mr Paul Fair, in Charge of Exhibits, United States Forest Service, San Francisco
APRIL 6	"Tumors" By Dr William Ophuls, Dean of the School of Medicine and Professor of Pathology, Stanford University School of Medicine
APRIL 13	"Recent Advances in Public Health" By Dr Herbert F True, Assistant Health Officer, City and County of San Francisco

April 20 — "Trichinosis and Its Prevention" By Dr Karl F. Meyer, Director of the Hooper Foundation, University of California Medical School

April 27 — "The High Cost of Quackery" By Dr E L Gilcreest, Instructor in Surgery, University of California Medical School

May 4 — "General Aspects of Tuberculosis" By Dr Robert A. Peers, Member of the California Department of Public Health

May 11 — "Pain" By Dr John Homer Woolsey, Assistant Clinical Professor of Surgery, University of California Medical School

May 18 — "The Cost of Being Sick" By Dr Morton R Gibbons, Lecturer on Medical Aspects of Insurance, University of California Medical School

October 5 — "Fur Seals A Million Dollar Business" Illustrated By Dr George Haley, Professor of Biology, St Ignatius College, San Francisco

October 12 — "Control of Predatory Mammals" Illustrated By Dr E Raymond Hall, Curator of Mammals, California Museum of Vertebrate Zoology, University of California

October 19 — "George Washington's First Wish" By Mr Edward Berwick, Pacific Grove, California

October 26 — "The Way Wild Animals Do Things" Illustrated By Dr W E Ritter, Professor of Zoology, Emeritus, Scripps Institution of Oceanography, La Jolla, California

November 2 — "California Floral Zones." Illustrated By Mr John Thomas Howell, Assistant, Department of Botany, California Academy of Sciences

November 9 — "Game Birds of California" Illustrated By Mr Donald McLean, Field Naturalist, California Fish and Game Commission

November 16 — "African Big Game" Illustrated By Mr N B Livermore Member Board of Trustees, California Academy of Sciences, San Francisco.

November 23 — "Our National Parks" Illustrated By Colonel John R White, Superintendent, Sequoia National Park, California

NOVEMBER 30. "Reptiles and Amphibians, with especial Reference to the Rattlesnakes of California" Illustrated with motion pictures and stereopticon slides. By Mr Joseph R Slevin, Curator, Department of Herpetology, California Academy of Sciences

DECEMBER 7 "A New Conception of Health Insurance as it vitally concerns the general public" Illustrated By Dr Ralph A Reynolds, San Francisco

DECEMBER 14 "The Mountains and Canyons of the Sequoia National Park" Illustrated By Mr Francis P Farquhar, Secretary Commonwealth Club, San Francisco

DECEMBER 21 "The Animal Kingdom The Reservoir of Disease" Illustrated By Dr Karl F Meyer, Director of the Hooper Foundation, University of California Medical School

DECEMBER 28 'The Natural History of Magpies" Illustrated By Dr J M Linsdale, Research Associate in the Museum of Vertebrate Zoology, University of California

LIST OF ACADEMY PUBLICATIONS IN 1930

PROCEEDINGS, FOURTH SERIES

Vol XVIII, Nos 17 and 18, pp 531-586 No 17—REPORT OF THE PRESIDENT OF THE ACADEMY FOR THE YEAR 1929, by C E Grunsky No 18—REPORT OF THE DIRECTOR OF THE MUSEUM AND OF THE AQUARIUM FOR THE YEAR 1929, by Barton Warren Evermann (Issued April 8, 1930)

Vol XIX, Nos 1, 2 and 3, pp 1-22 No 1, pp 1-6—MARINE MOLLUSCA OF GUADALUPE ISLAND, MEXICO, by A M Strong and G D Hanna No 2, pp 7-12—MARINE MOLLUSKA OF THE REVILLAGIGEDO ISLANDS, MEXICO, by A M Strong and G D Hanna No 3, pp 13-22—MARINE MOLLUSCA OF THE TRES MARIAS ISLANDS, MEXICO, by A M Strong and G D Hanna (Issued June 4, 1930)

Vol XIX, Nos 4 and 5, pp 23-56, plates 1 3, 4 text figs No 4, pp 23-40, plate 1, 4 text figures—SOME RISSOID MOLLUSCA FROM THE GULF OF CALIFORNIA, by Fred Baker, G D Hanna and A M Strong No 5, pp 41-56, plates 2 3—SOME MOLLUSCA OF THE FAMILY EPITONIIDAE FROM THE GULF OF CALIFORNIA, by Fred Baker, G D Hanna and A M Strong (Issued July 15, 1930)

Vol XIX, No 6, pp 57-64—PLIOCENE DEPOSITS NORTH OF SIMI VALLEY, CALIFORNIA, by W P Woodring (Issued July 15, 1930)

Vol XIX, No 7, pp 65-83, 3 text figs—GEOLOGY OF SHARKTOOTH HILL, KERN COUNTY, CALIFORNIA, by G Dallas Hanna (Issued July 15, 1930)

Vol XIX, No 8, pp. 85-93, 7 text figures—Fossil Bird Remains from the Temblor Formation Near Bakersfield, California, by Alexander Wetmore (Issued July 15, 1930)

Vol XIX, No 9, pp 95-104, 1 text figure—The Killifish of San Ignacio and the Stickleback of San Ramon, Lower California, by George Sprague Myers (Issued July 15, 1930)

Vol XIX, No 10, pp 105-108—Contributions to Oriental Herpetology IV Hokushu or Yezo, by Joseph R Slevin (Issued July 15, 1930)

Vol XIX, No 11, pp 109-215, plates 4-15—Marine Algae of the Revillagigedo Islands Expedition in 1925, by William Albert Setchell and Nathaniel Lyon Gardner (Issued December 30, 1930)

Handbook of the Birds of Golden Gate Park, San Francisco, by Joseph Mailliard

Items of Interest

Some notable changes have occurred in the personnel of the Officers of the Academy Mr M Hall McAllister resigned as Treasurer on July 1, 1930 In accepting his resignation, the Board of Trustees passed the following resolution

> "In accepting the resignation of Mr M Hall McAllister as a Trustee of the California Academy of Sciences, the Board does so with very great regret and feelings of real loss During Mr McAllister's many years of service as a member of the Board, he was ever watchful of the best interests of the Academy His services as Trustee and Treasurer were of the greatest help to the institution and the Board wishes to express its high appreciation of his deep interest in the welfare of the Academy"

Mr F W Bradley was appointed to fill the unexpired term

It is also to be noted that after long and faithful service beginning January 6, 1902, Mr J W Hobson retired at his own request from the office of Recording Secretary His services in this capacity terminated on February 19, 1930 It was with sincere regret that his associates on the Council saw his relinquishment, owing to physical disability, of the duties he had so long performed His place has been filled by Mrs J W. Hobson, who had for some time been assisting Mr Hobson in the keeping of records and other work connected with the office

On October 27, 1930, the Academy lost, by death, Gulian Pickering Rixford, for many years a member of the Academy, one time its Recording Secretary, and at the time of his death, Librarian since December 24, 1924 The vacancy caused by Mr Rixford's death was filled by his son, Dr Emmet Rixford.

On November 19, the Academy lost, by death, Colonel George Cunningham Edwards, also for many years a member and First Vice-President since January 21, 1907

Second Vice-President, Otto von Geldern, was appointed to fill the vacancy in the office of First Vice-President, and Dr Wm E Ritter was appointed Second Vice-President

Donations to the publication fund to be used in the publication of a handbook on the Birds of Golden Gate Park, by Joseph Mailliard, have been made during the year as follows

Mrs F W Bradley (Mary Parks Bradley)	$200
Mr Selah Chamberlain	200
Mr William H Crocker	200
Mr Herbert Fleishhacker	200
Mr J D Grant	200
Mr Chas Kendrick	200
Mr Edward J McCutcheon	250
Mr Louis F Monteagle	200

A donation of $1,200 to the Department of Botany was made by Miss Alice Eastwood, Curator of that Department By reason of this donation, Miss Eastwood became a Patron of the Academy

Mr McAllister has again contributed the sum of $100 to the Committee on the Conservation of Wild Life, of which he is Chairman For some years past he has made a like annual contribution

The Academy, some time ago, expressed its willingness to cooperate with the Seismological Society of America and has now allotted definite space in the basement of the museum building for the installation of a seismograph When this is installed the Academy will provide the necessary observer The installation is being made without cost to the Academy

Several months ago a representative of Karl Zeiss and Company was in San Francisco to awaken interest in the erection of a Planetarium The apparatus for a planetarium such

as the Adler Zeiss Planetarium of Chicago, the Fels Zeiss Planetarium of Philadelphia and the Griffith Zeiss Planetarium of Los Angeles, the latter about to be erected, is manufactured and furnished by the Zeiss Company While no progress appears to have been made in enlisting financial support for this project, opportunity was nevertheless afforded to the Academy to express its interest in the matter and to offer to accept the management of the planetarium if the same be located on some site convenient to the buildings of the Academy in Golden Gate Park.

The popularity of the Steinhart Aquarium has not waned On Saturdays, Sundays, and holidays, the Aquarium is frequently over-crowded More floor space is needed for the convenience of visitors and much more tank space is needed for additional material The aquarium at San Francisco should be second to no other aquarium in this country Appreciating this fact, an appeal was made to the city authorities several months ago for funds, in the amount of $750,000, for an extension to the aquarium This sum would suffice to treble the floor and tank space It would be a gracious act on the part of the City either out of current funds or by means of a bond issue to provide the money now needed for the enlargement of the Steinhart Aquarium It is hoped that this view will prevail

The Academy is about to begin the erection of the first unit of an East Wing in which the Leslie Simson African Mammal collection is to be installed Material for the exhibits sent from Africa by Mr Simson is arriving from time to time Our Curator of Exhibits, Mr Tose, has recently returned from Africa where he collected material for accessories and made color sketches of the habitats of the wild life which is to be put on display But here, as in the case of so many of the Academy's activities, not all can be done which should be done There is a sore lack of funds with which to erect adequate buildings In the circumstances the Academy has felt impelled to have recourse to its credit and has borrowed some $255,000 with which to begin the erection of its East Wing While this entails a large annual outgo for interest, yet it appears fully justified in view of the fact that Mr Simson has himself turned over to the Academy, or rather has placed

in escrow, property having an aggregate value of about $150,000, which will offset in some measure the Academy's proximate outlay of capital While this sum stands as the property of the Academy, the income therefrom must go to Mr Simson during his lifetime

In its present quarters the Academy has insufficient space. The collections are expanding in its various departments and even passageways are being over-stocked with cases of research material In view of this fact and because of the urgent need of extending research activities, the officers of the Academy made an appeal to the Rockefeller Foundation for funds with which to erect all of the proposed East Wing except only the Auditorium This application has quite recently been denied Building activities will, therefore, have to be restricted to the first unit, for a time at least, until some one comes to the Academy's aid with an adequate endowment or bequest

Plans for the East Wing of the Academy have been prepared by Architect Lewis P Hobart These had been sufficiently advanced a few weeks ago to permit calling for bids to construct the first unit thereof, which is urgently needed both for the housing of the African mammal exhibits as explained, and for the expansion of the Academy's research activities

Satisfactory proposals having now been received, it is expected that before the end of this year the building will be available for occupancy

In this connection a word relating to the finances of the Academy will not be out of place

The book value of the assets of the Academy appears at $2,143,629 At the time of the completion of the West Wing of its buildings in Golden Gate Park in 1916, the Academy was in debt about $350,000 This indebtedness was gradually reduced to $195,000 at which amount it stood when the new loan was made a short time ago for present building purposes, which, in the course of the current year, will bring the total indebtedness to $450,000 But as already explained, the increased indebtedness is in part offset by the property received from Mr Simson and now in escrow for the Academy

The valuable work being done in the Academy's departments will appear from the several reports of the Director of the Museum, of the Curators of the various departments, and of the Superintendent of the Aquarium. To all of those who have in any way contributed to the Academy's activities, I desire on behalf of our membership for whom I am speaking, to express sincere appreciation This extends, too, to the services of Attorney Edward Hohfeld who has ever been ready to assist with advice when called upon

In looking back over the year's activities, some progress is to be noted, but the Academy is still waiting and hoping for an endowment of sufficient magnitude to place it where it belongs,—well up in the front rank of like institutions elsewhere in the world

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL XIX, No 14, pp 411-482 MAY 29, 1931

XIV

REPORT OF THE DIRECTOR OF THE MUSEUM AND OF THE AQUARIUM FOR THE YEAR 1930

BY
BARTON WARREN EVERMANN
Director of the Museum and of the Aquarium

The Annual Report of the Director for the year 1929 was presented to the Academy at the Annual Meeting, February 19, 1930 The present report, submitted at this Annual Meeting, February 19, 1931, sets forth briefly the scientific and educational activities of the Academy for the calendar year 1930

PERSONNEL

The employees of the Museum as of January 1, 1931, were as follows: Dr Barton Warren Evermann, Director and Executive Curator of the Museum and of the Aquarium, and Editor of the Academy publications, Susie M Peers, Secretary to the Board of Trustees, Annie G Hobson, Recording Secretary of the Academy, Alice Eastwood, Curator, John Thomas Howell, Assistant Curator, and Kate E. Phelps, assistant, Department of Botany, Edward P Van Duzee, Curator, J. O Martin and Amy Williamson, assistants, Dr Edwin C Van Dyke, Honorary Curator, Dr Frank E Blaisdell, Research Associate, and Dr Frank R Cole, Associate Curator

in Dipterology, Department of Entomology; Frank Tose, Chief, and Richard Cayzer and Cecil Tose, assistants, Department of Exhibits, Dr Barton Warren Evermann, Curator, and H Walton Clark, Assistant Curator, Department of Fishes, Joseph R Slevin, Curator, Department of Herpetology, Dr Walter Kenrick Fisher, Curator, Department of Invertebrate Zoology, Thomas Cowles, Assistant Librarian, and Veronica J Sexton, Library assistant, Harry S Swarth, Curator, Mary E McLellan Davidson, Assistant Curator, and Joseph Mailliard, Curator Emeritus, Department of Ornithology and Mammalogy; Dr G Dallas Hanna, Curator, Dr Leo George Hertlein, Assistant Curator, Winifred Morrison, and John L Nicholson, Jr, assistants, Dr Frank M Anderson, Honorary Curator, and Dr Roy E Dickerson, Research Associate, Department of Paleontology; Constance W Campbell, stenographer, part time, Evelyn Larsen, office assistant, part time, Raymond L Smith, general assistant, Mabel E Phillips, check-room attendant, William C Lewis, janitor, Hugh Jones, assistant janitor; Allen Weatherwax, lecture attendant, Patrick O'Brien, day watch, Archie McCarte, night watch, Nellie Marshall, attendant, part time, Fred Tanaka, janitor, part time

The Aquarium staff and employees as of January 1, 1931, were as follows Dr Barton Warren Evermann, Director, Susie M Peers, Secretary, part time, Constance W Campbell, stenographer, part time; Evelyn Larsen, office assistant, part time, Alvin Seale, Superintendent, Robert J Lanier, Assistant Superintendent, Phyllis Beardslee, doorkeeper, Clynt S Martin, chief engineer, B. T Culleton, first assistant engineer, John A Dwyer, second assistant engineer, Clyde E Guidry, chief attendant, Jack Solini, first assistant attendant, L R. Solini, second assistant attendant, Leon Maxwell, third assistant attendant, Frank J Maxwell, relief engineer and attendant, S J Shenefield, carpenter and general utility man, Patrick O'Neill, janitor, Patrick McArdle, assistant janitor, Frank Haley, day watch

May Peffer, library assistant, resigned January 11, 1930 Her place was taken by Veronica J. Sexton, February 7. Barbara Cowles was employed as temporary library assistant from December 8, 1930, to January 1, 1931 Robert Thomp-

son, Jr, lecture attendant and library assistant, resigned June 10, 1930 Allen Weatherwax took his place as lecture attendant October 5, 1930 Russell Hendrick, assistant, Department of Exhibits, resigned May 16, 1930 Winifred Morrison began work as assistant in the Department of Paleontology, March 12, 1930 James Campbell was employed as temporary assistant in the Department of Fishes part time in 1930 Harold Thayer was employed as temporary assistant in the Department of Fishes from April 26 to June 12, 1930 Mrs Nellie Marshall began work as part time attendant February 9, 1930 Enid A Larson began work June 16 as temporary check-room attendant in the absence of Mabel Eleanor Phillips She was employed in this position up to October 15 She worked in the Department of Fishes from October 15 to November 15, and in the Department of Herpetology from December 1 to 6, 1930 Gust Anderson was employed as temporary night watchman in the absence of Hugh R Jones from September 1 to 20, 1930 J N Angelucci, third assistant attendant, resigned August 31, 1930 Leon Maxwell took his place September 1, 1930 Peter Busalacchi was employed as temporary help, November 12, 1930, in place of Leon Maxwell who was injured and temporarily unable to work Robert J Lanier was appointed Assistant Superintendent of the Steinhart Aquarium February 1, 1930 Charles W Hibbard, assistant collector, resigned November 16, 1930 Elsie von Larisch was employed as temporary typist from August 4 to October 31 Frank Haley took the place of James Cavanaugh as day watch

COOPERATION WITH PUBLIC AND PRIVATE SCHOOLS, WITH OTHER INSTITUTIONS, AND WITH INDIVIDUALS

The Museum continues to be of service to the schools, other institutions, and individuals in their educational and scientific work

All available space for public exhibits has long since been utilized, nevertheless, our Department of Exhibits continues, as material and time permit, to prepare new educational exhibits to put on display so soon as suitable exhibition rooms become available

During the year the research collections in the various departments increased greatly, particularly in the departments of Botany, Entomology and Paleontology, as is shown in the reports of the respective curators.

Twelve portable habitat groups of animals were loaned to the Berkeley public schools where they were kept in circulation throughout the school year At the end of the school year these portable exhibits are returned to the Academy for inspection and storing during the summer vacation. The Academy continues to loan to schools and investigators specimens of birds, mammals and other objects requested. And quite a number of investigators and special students come to our laboratories, particularly in botany, ornithology, herpetology and paleontology, for the purpose of special study

The Academy receives many letters from the general public, asking for information on many and diverse subjects, not all of a scientific nature.

These are usually referred to the appropriate department and the information requested is supplied, whenever possible, by the Director or the Curator of the department concerned This frequently requires a considerable amount of time in research or consultation of literature

VISITORS TO THE MUSEUM

	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
January		23,170	25,260	17,241	27,013	25,755	19,038	15,270	32,364	34,989	26,528	33,791	35,859	26,757	30,725
February		22,058	23,698	17,586	23,450	25,679	18,534	20,529	44,439	29,295	34,183	24,580	36,669	29,769	37,499
March		31,606	26,810	27,397	25,419	28 279	27,922	26,341	39,935	39,168	38,677	34,624	31,414	40,680	40,953
April		32,175	23,274	25,994	32,208	24,939	36,057	21,911	41 332	40,257	36,746	38,452	42,965	31,419	38,217
May		26,154	26 391	28,369	37,107	25,517	27,237	37,597	48,152	38,137	52,913	47,414	43,129	41,318	42,909
June		32,123	29,843	32,248	36,207	29,406	27,131	39,511	58,281	51,775	53,799	51,630	51 100	65,998	49,012
July		37,193	31,420	48 028	52 492	43,186	36,263	64,530	91,329	69,921	83 707	84,282	84,406	68,658	63,601
August		24,619	31 137	43,730	53,470	39 422	34 787	50,849	105,130	77,847	81,362	66,870	73,282	62,880	62,474
September	16,448	27,866	29,847	34,007	42,013	31 458	28,408	69,870	82,814	63,737	57,615	56,443	54,882	55,015	37,646
October	36,933	20,629	14,743	30,463	33,500	24,861	19,459	66 894	43,074	40,418	44,654	43,520	36,094	39,120	30,061
November	27,718	21,810	8,531	25,246	19,347	18 593	19,080	48,766	37,611	35,634	30,420	30,581	26,685	34,545	30,891
December	15,002	21,693	19,588	21,188	21,340	15,062	13,339	36,707	21,572	32,245	34,555	30,827	24 217	29,837	27,319
Totals for the years	96,101	321,096	290 542	351,497	403,566	332,157	307,255	498,775	646,033	553,423	575,159	543,014	540,702	525,996	491,307

Grand total since opening of the Museum September, 1916 6,476,613

VISITORS TO THE AQUARIUM

	1923	*1924*	*1925*	*1926*	*1927*	*1928*	*1929*	*1930*
January		82,283	72,153	38,259	44,300	53,454	41,160	49,538
February		119,001	61,213	66,032	39,515	54,105	44,070	66,755
March		88,172	97,986	82,153	58,151	57,083	75,876	76,193
April		83,245	79,021	64,830	65,337	78,735	50,583	69,362
May		97,083	75,187	94,521	87,961	104,230	92 048	98,295
June		112,785	94,717	91,451	70,151	110,206	91,936	92,538
July		145,703	128,261	127,999	142,738	151 881	115,018	123,267
August		148,899	144,208	124,635	115,230	115,915	106,681	104,310
September	29,800	116,032	106,492	86,645	87,909	92,755	121,143	74,347
October	209,671	71,273	72,350	79,108	66,117	51,521	68,304	60,776
November	145,434	67,500	59,074	49,741	44,643	50,554	72,149	59,138
December	96,757	48,376	52,929	48,423	43,582	36,406	53,658	56,593
Totals for the years	481,662	1,180,352	1,043,591	953,797	865,634	956,845	932,626	931,112

Grand total since opening of the Aquarium September, 1923 7,345,619

SCHOOLS VISITING THE MUSEUM IN 1930

Following is a list of the schools, the grades, teachers, number of pupils, and dates of visits in 1930

SAN FRANCISCO SCHOOLS VISITING THE MUSEUM IN 1930

DATE 1930		SCHOOL	GRADE	NUMBER PUPILS	TEACHER
Jan.	25	Everett Jr	H9	15	E Browne
"	31	Commodore Sloat	5th	38	M d'Erlach
"	31	Hawthorne	6B	36	F C Muller
Feb	4	Sherman.	6B	27	M Doran
"	6	Sherman	2-3B	66	C R Murray, A Turner
"	6	Le Conte	4A-4B	43	Jeannie Strassner
"	6	Sarah B Cooper	3A-3B	74	C MacCurra, T Meachum
"	7	Sherman	5B	33	M Denny
"	7	John Muir	Ungraded	14	M L Kennedy
"	8	Everett Jr High	G9-H9	15	Elsie Browne
"	13	Hawthorne	6H	46	C Hackman, M Gallagher
"	14	Golden Gate	4A	27	M Maughan
"	14	Columbus	6B	34	Isabel Elkins
"	17	Poly H S	L2-Biol	19	J Koehler
"	18	Jean Parker	4A	40	C Seidker
"	18	Patrick Henry	5A	33	E MacLean
"	25	Le Conte	3B	28	Miss Michel
"	26	Hawthorne	5A-5B	35	M E Doherty
"	26	Commodore Stockton	5A	33	H F Jamieson
"	28	E R. Taylor	3B	32	K M Brazell
"	28	Jean Parker	5B-6A	72	M Valsangiacomo
Mar	5	E R. Taylor	3B	25	O Wilcox
"	6	Grant	4B	40	E Johnson
"	6	Columbus	3A B	32	M K. Schnittger
"	16	Everett Jr High	Junior H	16	E Browne
"	10	Crocker Jr High	H9	30	M Hibbard
"	11	Argonne	6A	34	J A Plevin
"	11	Poly H School	10	18	Koehler
"	11	Francis Scott Key	4A	38	O Schell
"	14	Sarah B Cooper	Ungraded	14	R Stauer
"	14	Guadalupe	5A	38	M Johnson
"	14	Adams	3A 2B	24	A. McVeigh
"	15	State Teacher's College		17	Lea Reid
"	19	Outdoor School	Kindergarten	15	Marie Brown
"	20	Franklin	Jr Primary	22	Marie A Reilly
"	20	Galileo	High School	17	E Kluegel
"	21	Bret Harte	Ungraded	11	C W Sullivan
"	22	Everett Jr High	H9	10	E Browne
"	23	Portola	1-7th	46	M Crosby
"	23	Commodore Stockton	4A	24	H Jacobs
"	25	Sheridan	4A	31	M A. Lentz
"	25	Lincoln	Ungraded	10	F A Brierly
"	26	Monroe	5A	30	N P Hockley
"	26	Presentation	8B 7B	100	S Xaveria
"	27	Com Stockton	4A-4B	58	M Richter, M Holl
"	27	Burnett	3A	36	A Gibson
"	27	Sunnyside	5A	37	P Kelly
"	28	Argonne	2A	36	F Stockton
"	31	Lafayette	7th-8th	33	M Copeland
"	31	Junipero Serra	5A	40	Miss Akers

San Francisco Schools Visiting the Museum in 1930—*Continued*

Date 1930		School	Grade	Number Pupils	Teacher
April	2	Twin Peaks	1A-1B	21	Florence McNeill
"	2	Bernal	7B	34	Olive A Perry
"	3	Bernal	7A	35	B Kelly
"	3	Paul Revere	5A	37	M J Ludwig
"	4	Washington Irving	5B-6A	76	Edna Murphy
"	4	Sherman	Ungraded	11	C Middleton
"	5	Jefferson Union	8th	12	M Miller
"	5	Prescott	6th	34	M Campanari
"	5	Everett Jr High	Mixed	14	W Browne
"	8	Fremont	High 6th	37	S A. Perry
"	8	Galileo	High School	20	Miss Kautz
"	9	Poly High School	H9	13	Koehler
"	9	Dudley Stone	Special	33	G Mosby, M Jones
"	10	Guadalupe	6-7-8-Girls	43	K. Growney
"	10	Bryant	4-5	27	L Moncrieff
"	11	E R Taylor	4B Grade	26	E M Roth
"	11	Marshall	3A	28	M. Mack
"	17	Knightsen	2-3-4-5	30	A Frey, E Moody
"	18	Daniel Webster	Tumbling Cl	17	D Husing
"	19	Everett Jr High	Mixed	12	E Browne
"	21	Emerson	2A	25	M H Leibel
"	23	Jean Parker	Sight Con	12	U Duane
"	23	Hamlin School	3	12	
"	23	Sunnyside	6B	37	C Benelisba
"	28	Burnett	4A	39	L Sweeney
"	29	St. Agnes	Second	31	Sister Victorine
"	29	St Agnes	5	50	Sister Benegne
May	8	Longfellow	4B	39	J Kane
"	9	Mt Eden	Mixed	50	Misses Oliver, Good
"	9	Raphael Weill	2A	31	A J Johnson
"	13	Sunnyside	6A	27	Mrs V Kelley
"	13	Poly High School	L2	18	Koehler
"	13	Grant	7A	46	R. N Wilson
"	13	Hamlin	Jr Sr -Bot	12	S Davis
"	13	Lincoln	5A	26	D Rich
"	14	Parkside	4B	28	C T Bothe
"	14	Geary	3B	31	H Ekoos
"	14	Poly High School	L2	19	Koehler
"	15	Guadalupe	6A	32	T B Cummings
"	15	Paul Revere	3B	39	Evelyn Elster
"	16	Paul Revere	4A	38	D Christie
"	16	Knightsen	7-8	31	A. McKinnon
"	16	Cabrillo	Kindergarten	46	M Springer
"	19	Corpus Christi	6-7	60	Sister St Joseph
"	21	Notre Dame H S	Secretarial	41	Sisters
"	21	Fremont	H2	30	M Donelson
"	21	Lowell High	10th	5	A Schwartz
"	21	Redding	4A-4B	78	Misses Gardiner
"	22	St. Joan of Arc	6-7-8th	101	Sister St Joseph
"	22	Central	5 6th	46	Adeline Field
"	22	Lincoln	2-3d	54	A Hardy, B Steel
"	23	Bryant	4B	29	E Leary
"	23	Bryant	3A	40	M Koenecke
"	23	Hawthorne	5B	33	P E Nippert
"	23	Commodore Stockton	4B	35	A. Barter
"	26	Burbank	H8	28	H. M Williams
"	26	St. Peter's	3d-4th	100	M Roberts

San Francisco Schools Visiting the Museum in 1930—*Continued*

Date 1930		School	Grade	Number Pupils	Teacher
May	27	E R Taylor	6A	36	H Teping
"	27	St. Agnes	7th, Commercial	74	Sr M Martin
"	27	Poly High School	L2	20	M S Jussel
"	27	Polytechnic	L2-Biology	40	M S Jussel
"	28	Garfield	4th	50	C McKeon
"	28	Emerson	4B	38	H Bain
"	29	S San Francisco	6th	35	G B Gavin
"	29	Junipero Serra	4B	60	D L Baird
June	4	Crocker Jr High	H8	20	M Hibbard
"	5	Sarah B Cooper	6A	31	W J Karnes
"	9	S F S T College	V Zoology	30	B Kaunts
"	9	Woodrow Wilson Jr H	L9	15	M D Innes
"	9	Commodore Stockton	6B	37	G Morton
"	9	Commodore Stockton	6B	30	M Behn
"	10	Pacific Heights	5B	33	R E Dreyfus
"	12	Jefferson	3B	33	L Nolan
July	16	Teacher's College	College	17	B Kaunts
"	22	Teacher's College	College	11	B Kaunts
"	25	Teacher's College	Zoology	19	B Kaunts
Aug	1	Teacher's College	Zoology	17	B Kaunts
"	19	Columbus	4A-B	29	H B Grant
"	27	Raphael Weill	6A-6B	33	H Baxter
Sept	10	Edison	4B	30	C Reed
"	10	Edison	4B	36	R S Miller
"	10	Jefferson	Eighth	34	M H Traynor
"	14	Raphael Weill	1B	26	D Thompson
"	16	Lafayette	3B	36	M Harrington
"	17	Junipero Serra	2 4A 5A	86	Ahlgren, Baird
"	19	Bernal	8B	37	M C Beale
"	19	Lafayette	3B	38	L C Webb
"	20	Emerson	6A	32	Miss Currid
"	23	Franklin	3A-3B	38	S Hagerty
"	25	Golden Gate	3A-3B 4A	75	L King M Laug
"	25	Bay View	Low Seventh	35	I E Loughlin
"	26	E R Taylor	5B	34	L E Kamuff
"	26	Grant	4A	44	E Johnson
Oct	2	Miss Ransom s	8th	11	Regula Bernays
"	2	U of California	Landscape Design	8	H W Shepherd
"	3	Parkside	2B	29	A H Brcolini
"	3	Emerson	6B	38	A E Sharpe
"	6	Girls High	H8 Science	26	M Pettit
"	8	Central	3-4	44	R Grayson
"	9	Sherman	4A	31	E A Shipaugh
"	10	Franklin	L4th	40	E Callahan, G Hill
"	11	Emerson	5A	13	B Fortune
"	13	E R Taylor	3B	29	Olive Parker
"	14	Cabrillo	5B-6A	24	A B Green
"	15	Sunnyside	6th	34	C Benelisha
"	16	Laguna Honda	5B	32	B Meyers
"	16	Commodore Stockton	6A-6B	34	L Brovelli
"	16	St. Ignatius College	College	16	Geo Haley
"	16	Presidio Jr High	7th Grade	26	O C Neimarkel
"	16	Laguna Honda	5A	37	E Ohea
"	17	Bay View	8B	27	R I Morrow
"	17	Emerson	6A	58	D Le Jeune
"	17	Franklin	Low 4th	29	Jessymae Dodge
"	17	Girls High	H10	28	S Ward

San Francisco Schools Visiting the Museum in 1930—*Continued*

Date 1930		School	Grade	Number Pupils	Teacher
Oct.	17	E R. Taylor	6A	31	A Simonetta
"	20	Hawthorne	4th	35	Gertrude Flanagan
"	20	Hawthorne	2B-3A	39	M Coen
"	21	Frederic Burk	3d-4th	17	M Gold
"	21	Francis Scott Key	8th	31	A Dowling
"	21	Girls High	H10	36	S Ward
"	23	All Schools	Camp Fire	12	E. E. Boyes
"	24	St John School	High School	38	Sister Pauline
"	24	Garfield	4B	30	C McKeon
"	24	Garfield	4A	30	A. McDonald
"	24	Lafayette	4B	37	T L. Williams
"	27	Sarah B Cooper	5th	36	I. Brown
"	29	Guadalupe	5A	39	S Freer
"	29	Monroe	7A	28	P L. Plevin
"	29	Garfield	Ungraded	17	D L. Darvill
"	30	Emerson	4A	38	H Bain
"	31	Hawthorne	8A	41	M Lahaney
Nov	3	Frank M McCoppin	3A-3B	34	A. L Barrett
"	5	Bay View	7A	30	Ethel Maddocks
"	5	Jean Parker	6A	33	May Casey
"	8	Fairmont	6th	8	I Garwood
"	8	Westlake Jr High	H9	3	M Carmichael
"	10	Argonne	2d	29	L E Andersen
"	13	Galileo		19	A Kluegel
"	14	Garfield	4A-4B	30	C McKeon
"	14	Monroe	8A	27	E H Stern
"	19	Roosevelt	18	13	A G Soares
"	20	Jean Parker	3d	30	M Wramp
Dec	1	E R. Taylor	4A	30	Gwen Sellman
"	12	State Teacher's College		21	M Guernee
"	11	Howard Avenue	H8	24	W E Brown
"	11	State Teacher's College		24	M Guerrerd
"	11	State Teacher's College	Freshmen	60	E Pickard
"	11	State Teacher's College	Zoology	24	E Pickard
"	11	Laureau School	H8	14	W Naturik
"	17	State Teacher's College	Freshmen	20	E M Fisher

Schools Outside of San Francisco Visiting the Museum

Date 1930		School	Grade	Number Pupils	Teacher
Jan	10	Menlo Park	3d-4th	34	Ivy Laughlin
"	31	Washington, Alameda	8th	34	M Snyder
Feb	1	North Brae, San Bruno	Nature Study	12	Grace Seeney
"	4	Le Conte, Berkeley	6th	21	S Hamilton
"	28	Elem. School, Berkeley	3d	26	E Norton
Mar	6	Katherine Branson	2d	6	Isabel Chesnut
"	8	Crocker, Daly City	5th	33	M Packwood
"	8	Roseville, U High	Jrs.-Srs	13	S B Fleming
"	15	U C, Berkeley	Zool. 113	27	J Grinnell
"	22	San Mateo, Jr C	Biology	32	Dr Shepherd
"	28	Pleasanton	8th	25	M O. Noble
April	3	Central, Redwood City	6th	30	Irene Crosby
"	11	Pittsburg	4-8th	170	M Ellis, Youngberg
"	28	Felton, S. Cruz Co	6-7-8	32	M M Oliver

Schools Outside of San Francisco Visiting the Museum—*Continued*

Date 1930		School	Grade	Number Pupils	Teacher
May	2	West Park, Tracy		44	W R. Hoar
"	2	Amer Canyon, Napa Co	1-8th	45	V Schebler, B O'Hagan
"	3	Tech High, Oakland	Latin	60	H B Garrison
"	15	Jefferson, Colma	8th	27	M H Traynor
"	16	Irvington Grammar	8th	23	D G Scale
"	16	Columbus, Berkeley	4th-5th	90	S J Irwin
"	18	Melrose, Oakland	High 6th	19	L Bronner
"	21	Columbus	4th-5th-6th	65	M Wilson, Shapero
"	24	Tamalpais Park	4th	30	Edna Maguire
"	24	Belvedere	7th-8th	10	Myrtle D Ensign
"	24	Burbank, Berkeley	H-7th	16	C McKinnon
June	5	Jefferson, Colma	4th	32	H A Madonna
"	7	Walnut Creek	6 7-8th	114	M Parsons C Laggan
"	24	Laurel, Oakland	Low 6th	52	S Davidson
Aug	14	Intermediate, Lodi		23	E F Van Vlear
"	4	U C Berkeley	4A-4B	33	E W Gifford
Oct.	22	Edgemont, San Bruno	8th	37	Jane E Trigg
"	30	Franklin, Berkeley	High 4th	35	C McEneray
"	30	Franklin, Berkeley	High 6th	45	E J Seabury
"	31	Franklin, Berkeley	Special	18	G Hillyard
Nov	3	U C Davis	Zoology	19	Tracy Storer
"	14	S. T College, San Jose	2d	52	E C Walsh
"	14	University High, Oakland	10th	68	Jean M Nelson
"	21	University High, Oakland	L6th	86	E Lucas
"	21	Visitacion Valley	5B-6A	38	Helen Griswold
Dec	3	Weber College	Jr College	28	Eva Browning
"	4	Turnbull San Mateo	6th 7th	33	H J Neuling
"	8	Lomita Park	7th-8th	37	B MacKenzie
"	18	Burlingame, Y M C A		22	R Simrock

Summary

Schools of San Francisco		
Total Number of Pupils	6526	6526
Total Number of Teachers	208	
Total Number of Classes	216	
Schools Outside of San Francisco		
Total Number of Pupils	1676	1676
Total Number of Teachers	47	
Total Number of Classes	56	
		8202

SCHOOLS VISITING STEINHART AQUARIUM IN 1930

Following is a list of the schools, the grades, teachers, number of pupils, and dates of visits in 1930·

SCHOOLS OF THE CITY AND COUNTY OF SAN FRANCISCO

Date 1930		School	Grade	Number Pupils	Teacher
Jan	21	Geo Peabody	2A-2B	34	L Roach
"	23	Pacific Heights	3A	14	Miss Greenwood
"	31	Hawthorne	6B	36	F. C Muller
Feb	4	Sherman	6B	27	M Doran
"	6	Le Conte	4A-4B	39	J Strassner
"	6	Sarah B Cooper	3A-3B	72	C MacCarra, F Meachum
	7	Sherman	5B	33	M Denny
"	7	John Muir	Ungraded	14	M L. Kennedy
"	11	Alvarado	5B	60	G P Garety, R. Pennfeather
"	11	Hawthorne	6A	46	C Hackman
"	14	Columbus	6B	33	J W Elkins
"	14	Grant	6A-6B	35	Mrs. R N Wilson
"	14	Golden Gate	4A	27	M Maughan
"	18	Jean Parker	4A	40	C Seidkin
"	18	Jefferson	Kindergarten	39	D Decatur
"	26	Hawthorne	5A-4B	35	M E Doherty
"	28	Jean Parker	5B-6A	36	Norma Valsangiacomo
"	28	E R Taylor	3B	32	K M Brasill
Mar	1	Calvary Baptist Church	Juniors	9	Mrs K. R Camp
"	1	S F Sutro	Mixed	27	Florence Wiggins
"	5	C R Taylor	3A	27	A Wilcox
"	5	Columbus	3A-B	32	M K. Schullger
"	6	Grant	4B	38	E Johnson
"	8	Crocker School	High 5th	33	Mrs Peckwood
"	10	Crocker Jr High	High 9th	30	Miss M E Hibbard
"	11	Sarah B Cooper	Ungraded	14	P Stauer
"	11	F S Key	4A	36	C Schell
"	11	Rincon	1B-2A-2B	24	M Quinn
"	11	Polytechnic High	L2	21	M S Jussel
"	11	Polytechnic High	L2	27	M S. Jussel
"	12	Parkside	2A	25	A H Broolini
"	12	Adams	2B 3A	24	Alma McVeigh
"	12	Argonne	8B	30	D Boyisen
"	15	State Teacher's College		17	L Reid
"	17	Immaculate Conception Acad	Ungraded	12	Sister Margaret Mary
"	18	Lincoln	1B-2A-3B	62	Mrs. R. D Love Miss Jane Redmond
"	18	Polytechnic	L2	21	E Koehler
"	19	Polytechnic	L2	15	E Koehler
"	20	Franklin	Jun. Prim	22	Marie A. Reilly
"	24	Commodore Stockton	4A	24	Mrs. H Jacobs
"	25	Sheridan	4A	29	M A. Lentz
"	25	Lincoln	Ungraded	10	Mrs F A. Buerly
"	26	Edison	6B	35	M Kelly
"	26	Edison	6A	25	J O O'Brien
"	26	Edison	6A	19	A. Wilson
"	26	Raphael Weill	1B	24	M Villalon
"	26	Presentation	7th & 8th	97	Sister M Genevieve

SAN FRANCISCO SCHOOLS VISITING STEINHART AQUARIUM IN 1930—*Continued*

Date 1930		School	Grade	Number Pupils	Teacher
Mar	26	Lowell	H2	10	L. M Elskamp
"	26	Edison	6B	35	M Hardiman
"	27	Sunnyside	5A	36	F Kelly
"	27	Com Stockton	4B-4A	58	Mrs. Richter, Miss Holland
"	28	Presentation	3-4-5 6	85	Sr M Gabrielle
"	28	Argonne	2A	36	F Stockton
"	31	Lafayette	7-8	10	M Copeland
"	31	Com. Stockton	5B	38	L. Mitchell
April	2	Bernal	7B	34	Olive Alida Perry
"	2	Madison	2B	32	M Kilgariff
"	3	Bernal	7A	35	B Kelly
"	3	Paul Revere	5A	37	M J Luding
"	3	George Peabody	3A	32	E D Ruff
"	4	John Muir	3B 4A	54	Z Meyer, F Bleuler
"	4	Washington Irving	6A	40	Florence R. McInerney
"	7	Monroe	5	36	M Cunningham
"	8	Fremont	H6	37	S A. Perry
"	8	Polytechnic	L2-H2	19	H J Wilcox
"	9	Dudley Stone	Special	33	Mrs Jones, Miss Mosby
"	9	Frank McCoppin	8B	21	H Davis
"	10	Sarah B Cooper	6B	20	M D Roache
"	10	Guadalupe	3A	28	B Cole
"	10	Bryant	4-5	27	L Moncrieff
"	11	Marshall	3A	28	N Mack
"	12	Jean Parker		12	V Duane
"	23	Sunnyside	6B	37	Mrs C Beneliaha
"	25	Sarah B Cooper	2	25	J Antipa
"	25	Emerson	3A	28	I McCauley
"	29	Jefferson	2B	27	E K Hills
"	29	Golden Gate	2A	25	Elva La Rue
"	29	St Agnes School	5	50	Sr M Benigna
"	30	Polytechnic High	H2 Biol	21	L M Gladstone
May	6	E R Taylor	1	50	H Downey, F Geistofson
"	8	Longfellow	4B	39	J Kane
"	9	Washington Irving	6B 5B	65	Miss Doyle Mrs Dolan
"	13	Grant	7A	44	R. N Wilson
"	14	Parkside	4B	28	C T Bothe
"	14	Lincoln	5A	26	Dorothy Rich
"	16	Cabrillo	Kindergarten	45	M Springer
"	16	Paul Revere	4A	38	D Christie
"	19	St Pauls	6-7	9	Sr M Alphonsus
"	19	Corpus Christi	6-7	60	Sisters of St Joseph
"	21	Lowell High	10	50	A Schwartz
"	22	Lincoln	2-3	54	D B Steel, Alice Hardy
"	22	Alvarado	4A	57	M O'Shaughnessy, E. Crawley
"	22	Redding	4A 4B	76	S. M McMackin, G Gardner
"	22	Washington Irving	3B	40	E Cummings
"	23	Bryant	3A	40	M Koenecke
"	23	Bryant	4B	29	E Leary
"	23	Commodore Stockton	4B	35	A. Barter
"	23	Hawthorne	5B	33	Florence E Neppert
"	26	St Peters	3-4	100	Srs M Roberta & Edward
"	27	Polytechnic	L2 Biol	40	M S Jussel
"	29	So San Francisco	6	35	G B Gavin

SAN FRANCISCO SCHOOLS VISITING STEINHART AQUARIUM IN 1930—*Continued*

Date 1930		School	Grade	Number Pupils	Teacher
May	29	St Agnes	7	50	Srs Margaret Mary and Martina
"	29	Garfield	4A-4B	50	M Ivancovich
"	29	Emerson	4B	38	H Bain
"	29	Junipero Serra	4B	59	M Ahlgren, D L Baird
June	2	Monroe	8A	30	C A. Davis
"	2	Fairmount	7A	57	Mrs Holden, Miss Corpstein
"	3	Laguna Honda	8A	19	Mrs Rae, Miss Lynch
"	3	Monroe	7A	41	D Greenwood
"	4	Monroe	8A	31	E E Maline
"	5	Laguna Honda	7B	14	Miss Feehan, Mrs Rae
"	5	Sarah B Cooper	6A	31	W J Karnes
"	6	Park Boulevard Private School	1A-Kindergarten	20	Blanche R. Miller
"	9	Commodore Stockton	6B	66	G Morton, M Behm
"	10	Pacific Heights	5B	33	R. E. Dreyfus
"	12	John Muir	2A	40	Z. Coyle, M La Gomarsin
July	25	McKinley Orphanage		38	Marion Sommerin
Sept.	5	Cabrillo	4B	34	J Hampton
"	10	Edison	4B	65	R. Miller, C M Reed
"	12	Grant	1B	28	A Tiling
"	17	Junipero Serra	2-4A	86	M Ahlgren, D L Baird and G E Bell
"	18	Frederick Burke	L5	37	Miss Donhard
"	18	Lafayette	1B	32	Mrs Williams
"	19	F S Key	6B	29	E M Holchester
"	19	Lafayette	3B	38	L. Webb
"	20	Emerson	6A	32	Miss Currid
"	25	Bay View	L7	35	Ida E Loughlin
"	26	Grant	4A	44	E Johnson
"	26	E R. Taylor	5B	34	L. E Kamuff
"	27	So San Francisco Grammar	H4	10	Miss Broner
Oct	3	Frederick Burke	H5-L6	16	Miss Raemsch
"	3	Emerson	6B	38	A E Sharpe
"	6	Daniel Webster	Ungraded	13	Miss C Cuneo
"	10	Hancock	5A-5B	62	Mrs. Allmon, Mrs. English
"	14	Visitacion Valley	4A-B	25	F Flinn
"	17	E R. Taylor	6A	31	A. Simonetta
"	17	Bernal	7A	32	E L. Murray
"	17	Bay View	8B	25	Rose I Morrow
"	20	Jefferson	6B	38	M Shepston
"	20	Hawthorne	4	35	Gertrude Flanagan
"	20	Bernal .	7B	35	Mildred Cavanagh
"	21	Francis Scott Key	8	31	A. Dowling
"	21	Hawthorne	2B-3A	37	Mrs. M Coen
"	24	Girls High	H10	25	S. Ward
"	24	Garfield	4A	30	Alice McDonald
"	24	Garfield	4B	30	C. McKeon
"	27	Sarah B. Cooper	5	36	I Brown
"	27	Girls High	H10	27	S. Ward
"	29	Monroe	7A	28	P. L. Plevin
"	29	Guadalupe	5A	39	S. Frees
"	29	Garfield	Ungraded	16	D Dorsill
"	30	John Swett Junior High	L8	30	Miss Woodward
"	30	Alamo.	5A-5B	33	H Searight
"	30	Emerson	4A	38	H. Bain
"	31	Hawthorne	5A	39	M Lahaney

SAN FRANCISCO SCHOOLS VISITING STEINHART AQUARIUM IN 1930—*Continued*

Date 1930		School	Grade	Number Pupils	Teacher
Nov	5	Jean Parker	6A	33	May Casey
"	5	Bay View	7A	28	Ethel Maddocks
"	6	Argonne	3A	27	O Orr
"	7	Bernal	8A	34	Silvia Kresteller
"	10	Argonne	2	29	L. E Andersen
"	13	Garfield	6B	25	Mrs Scott
"	13	Monroe	7A-B	86	Misses Greenwood and Davini
"	13	Garfield	6A	29	J A. Boyle
"	14	Monroe	8A	26	E. H Stern
"	14	Garfield	4A-4B	52	C McKeon, B Kagel
"	14	Irving M. Scott	2A-2B	28	Mrs H McCourt
"	14	I M. Scott	4B 5A	29	Lucille Koenig
"	18	Roosevelt	L8	43	A G Soares
"	18	Polytechnic High School	L2	28	M S. Jussel
"	18	Roosevelt	L8	40	A G. Soares
"	19	Roosevelt	L8	42	A. G Soares
"	19	Polytechnic High	H2	21	Wilcox
"	20	Jean Parker	3A-3B	30	Mrs. P A. Wramp
"	21	Visitacion Valley	5B-6A	36	Helen Griswold
"	28	Woodrow Wilson	7	25	Mrs Nellie L. Raper
Dec	4	St Joan of Arc	5	22	Sisters of St. Joseph
"	6	South San Francisco	6	40	G B Gavin
"	10	State Teacher's College	1	20	Mrs. Guesseno
"	11	State Teacher's College	1A-Zool	75	Edith A Pickard, Edna Fisher and Mrs. Guesseno
"	12	State Teacher's College	Freshmen	20	M Fisher
"	17	Immaculate Conception Acad	11	30	Sister M Celestine
"	18	Sunnyside	7B	20	M Hoeft

SCHOOLS OUTSIDE OF SAN FRANCISCO VISITING STEINHART AQUARIUM IN 1930

Date 1930		School	Grade	Number Pupils	Teacher
Jan	10	Menlo Park School	3-4	34	Ivy M Loughlin
"	23	North Brae, San Bruno	6-7	41	Miss D Jones
"	31	Washington Alameda	8	34	M Snyder
Feb	1	Edinvale, Hayward	5-6	5	Mrs R. N Dwinell
"	1	Boy Scouts, Mill Valley	Troop 2	17	R. C Sproleder
"	4	Le Conte, Berkeley	6	21	S Hamilton
"	4	Livermore High School		23	O Murphy
Mar	6	Katharine Branson School, Ross	2	6	Isabel Chesnut
"	7	University Elementary School, Berkeley	5	32	Mrs. A S. Gist
"	8	Stanford University, Palo Alto	Medical	12	Dr Starks
"	8	Roseville Union High	3-4	13	Mrs. Sans, B. Fleming
"	15	U C., Berkeley	Zool 113	27	J. Grinnell
"	21	Walnut Creek, Walnut Creek	6-7-8	82	Mabel E McLoggan
"	21	Lafayette, Lafayette	7-8	27	Mrs. Clara Christian
"	21	Columbus, Berkeley	6	45	Miss Hogan, Miss Almy
"	23	Portola School, Portola	1-8	40	Miss Crosby
"	28	Pleasanton Gram , Pleasanton	8	25	Mrs. Gertrude Noble, V Bernard Johnson

Schools Outside of San Francisco Visiting Steinhart Aquarium in 1930—*Continued*

Date 1930		School	Grade	Number Pupils	Teacher
April	8	Daniel Webster, Oakland		16	D Husing
"	11	Pittsburg Grammar School	7-8	175	A. Huganey, W Yorenberg, W Ellis
"	12	E Morris Cox Oakland	H6	17	M E Geary
"	17	Knightsen	2-3-4-5	30	Mrs E Moody, Miss Agnes Frey
May	2	American Canyon, Napa Jct	1 to 8	43	Virginia Schebles, Bernadette Hays
"	2	West Park, Tracy	Adv Orchestra	43	Ernest Dobney
"	5	Prescott, Oakland	6	34	Miss Campanari
"	9	Mt Eden	4-5-6-7-8	50	Mrs Overacker Mrs. Good, Misses Oliver and Garsberger
"	10	Westlake Junior High, Oakland	H7	10	Grace M Taylor
"	15	Scotts Valley Santa Cruz	5-8	20	Ruby Owens
"	15	Jefferson, Colma	8	26	M H Traynor
"	16	Knightsen, Knightsen	7-8	31	Anne McKinnon
"	16	Columbus, Berkeley	4-5	90	S. J Irwin
"	17	Melrose, Oakland	H6	19	Lydia Bronne
"	21	Columbus, Berkeley	4-5-6	66	Mrs. Wilson and Shapero
"	21	Notre Dame, San Jose	Secretarial	37	Sister M Reginald
"	22	Central, San Mateo	5-6	44	A. G Field
"	22	Emerson Berkeley	6B	42	A. M Meginnes
"	23	Mt. Eden, Mt Eden	1 2-3	48	Edna S Overacker
"	24	Tamalpais Park, Mill Valley	4	30	Edna Maguire
"	24	Cragmont, Berkeley	4-5	15	Harry H Stoops
"	25	Jefferson School, Colma	4-5	26	Miss Doolin
June	4	St. Mary of the Palms, San Jose	7-8	30	Marion Burton
"	5	Jefferson, Colma	4	32	Hazel A Madonna
"	6	San Rafael Grammar	L8	22	C F Timony
"	7	Mission Grammar, San Jose	8	16	J B Vasconcellos
"	9	Woodrow Wilson, Jr High Oakland	L9	15	M D Innes
"	10	St. Vincents Vallejo	8	28	Sr Beockmans
"	20	Jefferson, Oakland	Mixed	23	Grace W Janoschik
"	24	Laurel, Oakland	L6	22	S. H Davidson
Aug	23	Calvin Coolidge School, Burlingame		42	Elinor H Statler
"	28	Wildwood, Piedmont	H3	18	Agnes Rathbone
"	28	Calvin Coolidge School, Burlingame		42	Mrs C C Kerson, Elinor H Statler
Sept	11	Jefferson, Colma	8	34	Marie H Traynor
"	13	Highland School Oakland	6A-6B	32	Marie L Spenser
"	26	Corralitos Union, Watsonville	7-8	22	Elma G Bradley
"	27	Presbyterian Sunday School Mountain View		33	Miss Center
Oct	8	Central, San Mateo	3-4	44	Reinecke and Grayson
"	10	Franklin School, Berkeley	L4	40	Edna M Callahan, Grace Hillyard
"	16	Lincoln School, Berkeley	Special	17	Charlotte Hayford
"	17	Franklin, Berkeley	L4	29	Mrs Dodge
"	22	Edgemont, San Bruno	8	34	Jane E. Trigg
"	30	Franklin, Berkeley	H6-H4	80	Mrs. Seabury
"	31	Franklin, Berkeley	Special	18	Cianciarulo and Hillyard

SCHOOLS OUTSIDE OF SAN FRANCISCO VISITING STEINHART AQUARIUM IN 1930—*Continued*

Date 1930	School	Grade	Number Pupils	Teacher
Nov 3	Univ Calif, Davis	1A-Zoology	25	Tracy I Storer
" 14	State Teacher's College, San Jose	2	52	Elisabeth Cameron Wilde
" 21	University High Oakland	L10	86	E Lucas
Dec 3	Weber College, Ogden, Utah	Jun College	28	Eva Browning
" 4	Turnbull, San Mateo	7-H6	33	Harry J Neuling
" 9	Lasear School Oakland	5-6	14	Rena Lesser
" 11	Lawrence School	H8	14	Warren Naturich
" 11	Howard Burlingame	8	24	William E Brown
" 15	Girl Scouts, Burlingame		18	Mrs. W H Cortelyou

SUMMARY

Schools of San Francisco	
Number of Visiting Pupils	6320
Number of Visiting Teachers	218
Number of Visiting Classes	221
Schools Outside of San Francisco	
Number of Visiting Pupils	2353
Number of Visiting Teachers	85
Number of Visiting Classes	101

DEPARTMENT ACTIVITIES

The year has been marked by commendable activity in the respective departments, as is evidenced by the annual reports of the several curators

In the Department of Botany the growth has been up to the normal, the number of herbarium sheets increased from slightly in excess of 171,000 in 1929 to more than 180,000 at the end of 1930 The various additions to the Herbarium will be found listed by the Curator in her departmental report

Collections were made by, or received from, members of the staff and from friends of the department from many different localities, all of which are fully recorded in the Curator's report

The California Academy of Sciences was represented at the Fifth International Botanical Congress which met in Cambridge, England, in August, 1930, by regularly appointed delegates as follows Miss Alice Eastwood, Curator of Botany, California Academy of Sciences, voting delegate; Dr Willis

L Jepson, Professor of Botany, University of California, Dr. Douglas Houghton Campbell, Emeritus Professor of Botany, Stanford University; and Miss Susie M Peers, Secretary, Board of Trustees, California Academy of Sciences

Besides attending the Botanical Congress, Miss Eastwood also attended the sessions of the International Horticultural Congress which met in London; she also took advantage of the opportunity to spend considerable time in the Herbarium of the British Museum and in the Royal Herbarium at Kew, where she examined certain collections of plants obtained in America She visited several botanic gardens for the purpose of studying the fuchsias, a group in which she is now especially interested

The Department of Entomology continues to grow under Mr Van Duzee's wise and enthusiastic supervision During the year the research collections increased by 20,694 specimens, a detailed statement of which is given by the Curator in his report

The laboratory of this department continues to be a popular meeting place for the local entomologists for the examination and study of species in which different ones are interested, for exchange of views, and for discussion of special problems in the field of entomology Among prominent entomologists who have devoted considerable time each week to research work in the department's laboratories are Dr F E Blaisdell, Dr E C Van Dyke, Mr E R Leach, Mr L S. Slevin and Dr Vasco M Tanner Among young entomologists who come quite regularly to the department for special research may be named Gorton Linsley, Graham Heid, Jas E Coute, Rev Edward Guedet, Eric Walther, Geo R. Wilson, R Blackwalder, Carl D Duncan, H. H. Keifer, Robert Usinger, Dr Paul Wilbur, E C Zimmermann, and T O. Zschokke

For the Department of Exhibits the year was a very active one. All of the habitat groups and other public exhibits were gone over carefully to see that they were not suffering in any way.

Early in the spring (May 27), Mr Tose, the chief of this department, left San Francisco to join Mr. Leslie Simson in Africa for the purpose of collecting accessory materials and making sketches for the use of the artists who will paint the

backgrounds for the habitat groups of African game animals which Mr Simson is now collecting for the Simson African Hall that will form the principal unit in the Academy's new building, construction work on which is just now beginning and which, it is hoped, will be completed next October

The Library, under the supervision of the Assistant Librarian, Mr Thomas Cowles, has made satisfactory growth Mr Cowles has been active in completing the Academy's file of important serial publications of learned societies and scientific institutions With the cooperation of the curators of the respective departments the growth of the Library has been as rapid as our funds would permit

It is a matter for deep regret that the income of the Academy does not permit a larger allotment for library purposes, a condition which obtains in an equally great degree with the other departments

Mr H Walton Clark, Assistant Curator, Department of Fishes, devoted much of his time to curatorial work such as transferring the Jordan-Eigenmann Indiana University collection to permanent containers, re-bottling, labeling, arranging, and supplying with fresh alcohol and new labels where necessary

Similar attention has been given also to the general collection

Arrangements have been made with Mr George S. Myers whereby he will study and report upon certain portions of the Ternetz collection. Mr Myers has already begun that study and will probably have his report completed within a year from now

It is expected that the East Wing of the Museum will be completed by the end of 1931, when the Department of Fishes will be moved into the basement under the Simson African Mammal Hall of that building, where commodious and excellent quarters will be found

The Department of Herpetology has had a successful year, as is shown by the report of the Curator, Mr Slevin. At the beginning of the year Mr Slevin was still in Australia. He left Australia February 22, 1930, and returned to America March 13 The expedition resulted in the addition of speci-

mens to the Academy's herpetological collections, which now number by actual count 66,722

The Department of Ornithology and Mammalogy, as may be seen from the Curator's report, has had a satisfactory year The accessions have been many, considerable field work was done, and much important research work was accomplished The outstanding event of the year was the visit of Curator Swarth to London and Tring to study Galapagos finches in the British Museum and the Rothschild Museum, and to Amsterdam where he attended the Seventh International Ornithological Congress, June 1-8

Another matter of general interest was the completion by Curator Emeritus Mailliard, and the publication by the Academy, of an attractive and very useful handbook on The Birds of Golden Gate Park This publication supplies a long-felt want for a handbook of the birds of the Park Mr Mailliard's book meets this need admirably

The Aquarium has not lost any of its popularity with the public, as may be seen from the record of the number of visitors, and the comments which are heard and the letters received

The report of Superintendent Seale shows that the number and kinds of fishes and other animals on exhibition compare favorably with those of the previous year

The Matson Navigation Company continues to cooperate with the Academy by bringing fishes to the Aquarium from the Hawaiian Islands, from Samoa, and from Australia The specimens from Samoa are particularly beautiful

There are so many more species of fishes and other aquatic animals that would make very attractive and instructive exhibits, and which we can not now display because of lack of sufficient space, that the Aquarium should be enlarged President Grunsky has presented the matter to the City Supervisors and it is hoped that favorable consideration may be given to the recommendation

The Department of Paleontology had a satisfactory year Because of lack of space for housing collections, field activities primarily for the purpose of securing research material were confined to those necessary in connection with work already begun for which additional material was needed

With the construction of our new building and the transfer of the Department of Entomology to it, the rooms now occupied by that department will be assigned to the Department of Paleontology, which will give Paleontology quarters which will prove very satisfactory and ample for several years to come.

The members of the staff of this department continue to be in demand by oil companies who wish their assistance in field investigation Assistant Curator Hertlein was loaned for several months to the Hudson's Bay Oil and Gas Company to carry on geological explorations in Alberta, which afforded Dr Hertlein opportunity to obtain considerable collections of Cretaceous fossils from that region Many students from various parts of the country visited the department during the year and made use of the collections in connection with studies on which they were engaged.

The department continues to help specialists by loaning certain specimens or collections which they need to examine in their special studies

The acquisition of the large Baldwin collection of mollusks by the Department of Paleontology in 1928 has been briefly noticed in preceding reports The full value of it could not be realized until some progress had been made in unpacking and installing it in the Academy's research series This work has now been practically completed and the collection will stand as an indelible monument to the industry of this early Hawaiian collector In connection with the checking of records pertaining to the collection some very interesting biographical notes were compiled by Messrs Hanna and Church These are reproduced in full below

DAVID DWIGHT BALDWIN, 1831-1912

BY G D HANNA AND C. C. CHURCH

In 1928, the California Academy of Sciences received as a gift from his heirs, the large and varied collection of shells of the late D D. Baldwin.

The collection consists of land and fresh water shells from various parts of the world and especially marine, fresh water and land shells of the Hawaiian Islands One large case of

marine shells was exhibited at the Alaska-Yukon-Pacific exposition at Seattle, Washington, in 1909 and was awarded a gold medal The Hawaiian land shells are represented by a considerable number of the beautifully varied tree and ground snails famous among conchologists the world over, for their bright colors and intricate design

During all the years in which he was collecting shells on the islands, Mr Baldwin's own family was only mildly interested in his work, but sometimes they did help him collect, and his oldest son E D Baldwin, a surveyor, was sufficiently interested to do some good collecting on his own account. However, in his will, Mr Baldwin made it known that he wished his own family to have the collection which they had made together. To each member he willed the part in which he or she had been most interested To Mr E D Baldwin he gave the bulk of the Hawaiian land shells, to Mrs Lilian B Atwater and Mrs Duncan B Murdoch he gave the marine shells, and the land and freshwater shells from other parts of the world he gave to Mrs Winifred B Weddick

Soon after this disposition was made the Bishop Museum of Honolulu acquired the collection of land shells received by E D Baldwin, but the remainder of the collection, left at the Haiku home after the break-up of the family, was passed unnoticed and forgotten It was not until 1928 that the junior author, in a chance conversation with Mrs Winifred Brewster (now Mrs Morrison), a granddaughter of D D Baldwin, learned of the collection An effort was then made to bring it to light and through the hearty co-operation of Mrs Morrison and the heirs mentioned above, the collection (with the exception of the part secured by the Bishop Museum), was recovered from the old deserted Haiku house, packed and sent to the California Academy of Sciences Miss Lucie Hicks acted as representative for the Academy in going to Maui, meeting the donors and in arranging for packing and shipping. Mr. Duncan Murdoch did the greater part of the hard work of crating the cases and assisted Miss Hicks in the packing. Mr. and Mrs Murdoch and Mrs Weddick are to be especially commended for the kindly reception given Miss Hicks Dr H A. Pilsbry has assisted us in compiling the bibliography given below

In view of Mr. Baldwin's work in the Hawaiian Islands, not only as a collector in the field of Botany and Zoology, but as a pioneer in education and agricultural development, we believe it to be of timely interest to set forth the salient features of his long and varied career

David Dwight Baldwin was born at Honolulu, November 26. 1831. His father, Rev Dwight Baldwin, M D, was originally from Durham, Conn, and came to the islands with the fourth band of missionaries which left New Bedford, Mass, December 28, 1830, and sailing around Cape Horn, arrived at Honolulu June 7, 1831 Rev Dwight Baldwin had graduated from Yale College in 1821 and Auburn Seminary in 1829 and it was only natural that when his son had completed his work at Punahou School, Honolulu, he should go on to Yale In 1852, he sailed east around Cape Horn and, arriving at New Haven, was admitted to Yale the next year He graduated from that institution in 1857 with the A B degree and the honor of having won the De Forrest astronomical prize The winning of this distinction in astronomy is the first indication we have of his scientific inclinations

On October 7, 1857, he was married to Lois Gregory Morris, a descendant of Robert Morris, famous financier of the American Revolution, and shortly afterwards the couple set sail for the Hawaiian Islands The young huband's knowledge of astronomy was to be of invaluable service to the party on this trip, for soon after embarking he discovered that the captain of the ship sailed only by "dead reckoning" From then on to the end of the long cruise he navigated the ship and delivered the party safely into the harbor of Honolulu

This date marks the beginning of Mr. Baldwin's active life on the islands From 1857-1864 he was a cane planter at Lahaina, Maui, and two of these years (1861-1862) he was a member of the Hawaiian legislature. From 1865 to 1872, he was manager of the Kohala Sugar Company, from which he resigned to go back and spend another year at Yale. While attending school he worked as librarian of the law school and received his M. A. degree in 1874

On his return to the islands in 1874 he was made vice-principal of Lahaina School. His work there must have been very satisfactory, for in 1877 he was appointed Inspector-

General of Schools under the monarchy, a position which he held for eight years. His work earned for him the title of "Father of English Education in Hawaii." He was first to introduce English as a basis of education in the schools of Hawaii

In 1885 he was made vice-principal of Lahainaluna School and held the position until 1890, when he moved to Haiku, Maui, to become principal of Hamakuapoko School and pioneer pineapple planter of Maui From 1903 to 1912 he was vice-president of the Haiku Pineapple Company. He died June 16, 1912, at Honolulu Notice of his death was published in The Nautilus, vol 26, August, 1912, and a brief account of his life with a portrait was published the following November in the same journal, vol 26, 1912, pp. 82-83

About the year 1850, when Mr Baldwin was a very young man, an active interest in the collection of land shells was awakened in the islands Many collectors entered the field and it is quite probable that at this time he did his first systematic work This period of land shell excitement is still known in the islands as the period of "the land shell fever." It lasted for several years and we know that by 1852 when the young man left Oahu to go to Yale, he had made a considerable collection of shells. While in school at New Haven he must have studied and developed an interest in botany, for on returning to the islands in 1851 he devoted much of his spare time to the study and collection of the native ferns and mosses, however, he did not neglect the land shells which were found and must have added considerably to his collection during this period.

On rare occasions during these early years on Maui, Mr Baldwin enjoyed taking his family into the wooded hills for whole days of collecting Each member of his family was instructed just where to look for the different kinds of snails—on which kinds of trees—under which special ferns—and quick young eyes were soon expert at spying out the rare and hidden ones Much was accomplished during these years and although Mr Baldwin did very little publishing himself, he was very generous in supplying material to those who did and many shells and ferns were named for him

While Inspector-General of Schools he was living at Honolulu, and near his home at Punahou he had a small cabin which

he fitted up for a workshop and display room for his shells. He took great pride in this miniature museum and many of his friends were taken there to see and discuss with him his beautiful collection.

In 1890 he moved to Haiku, Maui, and from then to 1910 was his most prolific period as a writer and collector of the Hawaiian land shells. He was in active correspondence with conchologists and botanists in many parts of the world and by exchange of specimens he built up a very considerable collection of foreign shells. It was also during this last period that he began to assemble the marine shells of the islands and much success attended his efforts.

In 1893 he published his "Catalogue of the land and fresh water shells of the Hawaiian Islands," which is often referred to because of the accuracy of identifications and localities. The following bibliography of his writings is as complete as we have been able to make it.

1 Land shells of the Hawaiian Islands <Hawaiian Almanac and Annual (Thrums), 1887, Honolulu, also issued separately, pp 1-9

2 Catalogue Land and Fresh Water Shells of the Hawaiian Islands <Honolulu, Press Publ Co May, 1893, pp 1-25

3 Descriptions of new species of Achatinellidæ from the Hawaiian Islands. Proc Acad. Nat Sci. Philadelphia, vol. 47, 1895, pp 214-236, pls 10, 11

4 Description of two new species of Achatinellidæ from the Hawaiian Islands <Nautilus, vol 10, 1896, pp 31-32

5 List of indigenous Hawaiian woods, trees and large shrubs <Hawaiian Annual (Thrums), 1897, pp 87-91

6 Hawaiian Cypræidæ <Nautilus, vol 11, 1897, p 123

7 Land shells of the Hawaiian Islands <Hawaii's Young People, vol 4, No 7 [No 30], May, 1900, pp 194-196

8 Land shell collecting on Oahu. <Hawaii's Young People, vol 4, No 8 [No. 31], June, 1900, pp. 239-243

9 Descriptions of new species of Achatinellidæ from the Hawaiian Islands <Nautilus, vol 17, 1903, pp. 34-36.

10 Description of new species of Achatinellidæ from the Hawaiian Islands <Nautilus, vol 19, 1906, pp 111-113, 135-138.

11 Descriptions of new species of Achatinellidæ, from the Hawaiian Islands <Nautilus, vol 22, 1908, pp. 67-69.

Because of his extensive collecting and generosity in exchange, a considerable number of shells and plants have been

named in his honor. Those which have been found are listed as follows:

ZOOLOGY

Baldwinia Ancey (Section)
Amastra baldwinana Pilsbry
Tornatellaria baldwiniana Cooke & Pilsbry
Achatinella baldwinii Newcomb
Leptachatina baldwini Cooke
Tornatellina baldwini Ancey
Philonesia baldwini Ancey
Endodonta baldwini Ancey
Cecilioides baldwini Ancey
Succinea baldwini Ancey
Helicina baldwini Ancey
Melania baldwini Ancey
Nanina baldwini Ancey
Hyalinia baldwini Ancey
Charopa baldwini Ancey

BOTANY

Asplenium baldwini Hillebrand
Hymenophyllum baldwini Eaton
Polypodium baldwinii Baker
Leucobryum (Euleucobryum) baldwini Müller
Polytrichum (Aloidella) baldwini Müller
Distichophyllum (?) *freycinetii* var *baldwinii* Brotherus
Bryum baldwinii Brotherus
Daltonia baldwinii Brotherus
Calymperes baldwinii Brotherus
Bartramia baldwinii Brotherus
Webera baldwinii Brotherus
Fissidens baldwinii Brotherus
Sematophyllum baldwini (C. Muller)
Philonotis baldwinii Brotherus
Neckera baldwini Müller
Hookeria baldwinii Brotherus
Leucoloma baldwinii Brotherus

This list of papers and named specimens, in all probability, is not complete but it does comprise the better known and more accessible things Therefore, it will indicate the general scope of the man's life and work.

DEPARTMENT REPORTS

DEPARTMENT OF BOTANY

The herbarium at the end of 1930 numbered over 180,000 mounted sheets with many specimens still unmounted. The Department quarters are becoming so crowded that more space is imperatively needed.

Duplicates in exchange have been sent to the following institutions. Arnold Arboretum of Harvard University, 100; Dudley Herbarium, Stanford University, 368, Field Museum, Chicago, 791; Gray Herbarium, Harvard University, 476; Missouri Botanical Garden, St. Louis, 117; New York Botanical Garden, 113; Pomona College, Claremont, 130; Dr S. F. Blake, Washington, D C., 133; United States National Herbarium, 68, University of California, 490; University of Montreal, 290.

Specimens have been received in exchange as follows Arnold Arboretum of Harvard University, 211, Dudley Herbarium, Stanford Uni-

versity, 273; Field Museum, Chicago, 143, Missouri Botanical Garden, St. Louis, 51, Dr. S F. Blake, Washington, D C., 42, United States National Herbarium, 105, University of California, 352, University of Montreal, 556

Specimens have been purchased as follows: Dr Donat, Patagonia, S. A., 100, Marcus E. Jones, 361 from Mexico and 215 from Arizona, Ines Mexia, 100, Mexico, Mrs. E. C Van Dyke, 472, western United States; S. Venturi, 328, Argentine, S A, Carl Wolf, 961, south-western United States

Gifts of plants have been received as follows: F. M. Anderson, 10 from Colombia, S. A; Mrs. J C. Augsbury, 12 from Indio, Ivan Branson, 26 from Kit Carson Pass, Mrs W I Follett, 11 from Plumas Co; Cecil Hart, 55 from southern California; Martha Hilend, 14 from southern California, Ralph Hoffmann, 362 from southern California and the Channel Islands, John Thomas Howell, 8217, mostly from California, Mrs B. R. Jackson, 30 from California, Katherine Jones, 15 native and exotic from California, M S Jussel, 440 from the Dardanelles of the Sierra Nevada, David D Keck, 21 Phacelias from the western States; Isabel T. Kelly, 71 from Modoc Co. and southern Oregon, H C. Kramer, 38 from Prospect Peak, Lassen Co; Enid Larson, 11 from Inyo and Mono Cos, Frank W Peirson, 90 from southern California and the western States; Mrs George H. Phelps, 27 from Napa Valley; L. S Rose, 165 from California, Mrs E. C. Sutliffe, 39 Hepaticæ, Eric Walther, 475 exotics from Californian gardens

By exploration, the following collections, not including duplicates for exchange, were made: Alice Eastwood, 187 from Arizona, 144 from California, and 11 from Panama, J T. Howell, 500 from California

The Academy herbarium continues to serve all parts of California as a bureau of information on correct plant names in both native and exotic species. The herbarium is being used by loans and reference by research students in many parts of the United States During the past year 2235 herbarium specimens have been loaned The following are among those who have arranged loans more recently: Dr. L. H Bailey, Ithaca, N Y., Dr S F Blake, U. S Bureau of Plant Industry, Washington, D C, Dr C C. Epling, University of California at Los Angeles; Dr A. Grant, Missouri Botanical Garden, St Louis, Mr Morris Halperin, Division of Agronomy, Davis, California, Miss Martha Hilend, University of California at Los Angeles; C. L. Hitchcock, Missouri Botanical Garden, St. Louis, Dr David D Keck, Carnegie Laboratory, Stanford University; Dr P A Rydberg, New York Botanical Garden, Dr Paul C. Standley, Field Museum, Chicago, Dr E. E. Stanford, College of the Pacific, Stockton; Miss S. G. Stokes, San Diego.

During the summer the herbarium was thoroughly fumigated with carbon-bisulphide The collections are in excellent condition and are entirely free from herbarium pests; this noteworthy condition being maintained by annual fumigation of the entire herbarium, by double fumigation of all exchanges, loans, gifts, and purchases, and by constant vigilance

The curator collected 187 specimens, not including duplicates, on a trip to Arizona at her own expense and as a guest while there of Mrs. Susan Delano McKelvey It was in March, somewhat too early for flowering plants, but the proper season for ferns. Other short trips were taken to various places in northern California.

In July, the curator, as a voting delegate from the California Academy of Sciences, left to attend the Fifth International Botanical Congress held in Cambridge, England She attended the sessions of the International Horticultural Congress in London While in England, some investigations concerning species collected by Archibald Menzies when naturalist on the "Discovery" with Vancouver were made at the Herbarium of the British Museum and the Royal Herbarium at Kew Visits were made also to the Botanical Gardens at Cambridge, Edinburgh, and Dublin, and several flower shows sponsored by the Royal Horticultural Society, as well as the great late summer flower show at Southport, were attended. In order to attempt to bring stability to the nomenclature of the hybrid fuchsias in cultivation, the curator collected named specimens at various botanic gardens and nurseries The results will be published later by the American Fuchsia Society The curator paid her own expenses and also the salary of the extra help needed in the herbarium during her absence, amounting to $1,200

June 1, Mr John Thomas Howell became assistant in the Department, and had charge of the herbarium during the absence of the curator, and on January, 1931, he became Assistant Curator of the Department He has given to the California Academy of Sciences his entire herbarium consisting of over 8000 specimens, many from the deserts of southern California, these being notable additions to the Academy collections In May, before beginning work, Mr Howell was the guest of Mr. Frank W Peirson of Altadena on a profitable collecting trip to the mountains of eastern San Diego Co. and to the western Mojave Desert, Kern Canyon, and Greenhorn Range On that trip over 450 specimens were collected. During the summer and autumn, 16 week-end collecting trips were arranged by Mr Howell with friends and made with no expense to the Academy In this way over 500 specimens as well as numerous duplicates for exchange purposes were collected

Mrs. George H Phelps not only mounts all the specimens for the herbarium, but attends to the flower show in the vestibule of the Museum, distributes specimens into the herbarium, and attends to drying all the fresh specimens that are continually coming in. Mrs. E. C. Sutliffe brings specimens for the herbarium and the flower show and looks after the increasing collection of Hepaticæ Mr Eric Walther adds continually to the collection of the exotics cultivated in California and also brings in specimens from the park and other gardens for the flower show. His aid is invaluable

The California Botanical Club holds weekly meetings or excursions during most of the year, and the class of gardeners has been conducted in the herbarium twice monthly except during the absence of the curator

ALICE EASTWOOD, *Curator*.

DEPARTMENT OF ENTOMOLOGY

The work in the Department of Entomology has progressed along much the same lines as in former years. Less field work was done but more time was put into the arrangement of the collection in the new cases and in mounting material previously received.

Additions to the Department during 1930 number 20,694 specimens. Some of the more important lots that go to make up this total are the following. From Mr J O Martin, 5540 insects taken in field work in Texas and Arizona, from Mrs Joseph Gunn of Berkeley, a collection of 3300 butterflies made by her son, the late Norman R. Gunn, from Dr. E. C Van Dyke, 3100 insects exclusive of the Coleoptera, taken on a trip through the Yellowstone and Glacier National Parks, from Mr T O Zschokke, by purchase, 2510 insects from the Panama Canal Zone, an important geographical region but poorly represented in our collections, from Mr Louis Slevin, 1462 insects, mostly moths, taken about Carmel, California, from Mr Joseph Slevin, 430 insects taken by him while engaged in field work in Australia, from Mr E A. Dodge, 403 Lepidoptera, including a very complete series of western Hesperidæ or "Skippers", from the Bishop museum of Honolulu through Mr E. H Bryan, 275 miscellaneous insects from Pennsylvania, from Dr P H Timberlake, 227 bees, largely paratypes in the genus Perdita, from Dr. H M Smith, through Dr Barton Warren Evermann, 119 insects, mostly butterflies, from Siam, and through field work by the curator, 2073 insects, mostly taken on a short field trip through the "Mother Lode" country in the foothills of the Sierra Smaller but valuable additions were received from several sources, Mr Morton Swarth gave us the butterflies taken by him at Atlin, B C, Mr G. F Knowlton, insects from Utah, Mr Graham Heid, butterflies from Japan, Mr E. C. Zimmermann, beetles from Chile, Dr John A Comstock, a series of two species of rare moths from southern California, Mr R F Sternitzky, the types of a new Lycaenid described by him, Mrs. M E Davidson, insects from Panama, Dr S F Light, insects from Lower California, Dr F E. Blaisdell, Mr. Ralph E. Barrett, Mr E. R Leach, Mr W S Wright, and Mr J R Strohbeen, insects from California, and Mr M C. Van Duzee, insects from western New York

Mr J O Martin continued to put in most of his time on the classification and arrangement of our large collection of beetles, Dr F E Blaisdell has spent two days a week for most of the year in this same work, and Dr. E C. Van Dyke has found some time to work here each week These, with the other students who improve the opportunity for insect study offered by the Academy, have kept the limited desk space in this department more than full most of the time

The addition during 1930 of twelve more insect cases and 388 of our standard insect drawers has greatly relieved the congested condition of the storage facilities in this department We now have 576 drawers available for the Coleoptera, 192 for Hemiptera, and 192 for Lepidoptera, and as the arrangement of our material in these three orders

progresses the vacating of the pine cases allows the arrangement of certain groups in other orders of insects.

In anticipation of the possible removal of the Department of Entomology to larger quarters within the present year, it seems worth while to take stock of the collection as of January 1, 1931. Since June, 1916, when the present curator took charge of this Department, a count has been kept of all material added to the collection as it came in These additions number 672,750 specimens To this must be added an estimated 20,000 in the collection before June, 1916, and perhaps 235,000 still uncounted and unarranged, in the Van Dyke, Blaisdell, Koebele and Van Duzee collections This makes a total of about 880,000 specimens now in the collection in this Department

In addition to the general collection of insects in this Department, fourteen special collections have been received and now form components of the Academy Collection These total about 525,000 specimens or about two-thirds of the total recorded above For the proper assorting and arranging of this material we will need nearly 200 of the standard cases used in this department of which we now have about 50 The proposed new rooms for this department have 4000 square feet of floor space This will give the department space for about 224 insect cases, and for adequate laboratory facilities for 10 years more of normal growth With these added laboratory facilities it will be possible for the staff to accomplish more and we will be able to do more for the constantly increasing number of visiting students who are using our material.

The fourteen special collections are

J G. Grundel Collection of Lepidoptera	about 3,000 specimens
W G Wright Collection of Lepidoptera	about 2,000 specimens
F X Williams Collection of Lepidoptera .	7,662 specimens
E J Newcomer Collection of Lepidoptera .	1,737 specimens
R H Stretch Collection of Moths	3,141 specimens
E. C. Van Dyke Collection of Coleoptera, estimated as	200,000 specimens
H M Holbrook Collection of Butterflies .	500 specimens
E P Van Duzee Collection of Hemiptera, estimated as	30,000 specimens
F E. Blaisdell Collection of Coleoptera, estimated as	125,000 specimens
J C. Huguenin Collection of Lepidoptera	1,870 specimens
Albert Koebele Collection, all orders, estimated as	100,000 specimens
L. S Slevin Collection of Coleoptera	22,200 specimens
C. L. Fox Collection of Hymenoptera	16,800 specimens
J O Martin Collection of Coleoptera	11,200 specimens

The California Academy of Sciences now has the largest collection of insects on the West Coast With the necessary cases and curatorial help it would take its place as one of the most important collections of insects in this country, in fact in several of the insect orders its fine series of western forms must now be consulted by any one attempting to do monographic work on our western species

Edward P Van Duzee, *Curator*

DEPARTMENT OF EXHIBITS

The entire collection of groups and floor exhibits in the Mammal Hall has been thoroughly overhauled, and a group of Marten *(Martes caurina sierræ)* installed in the last remaining space available for this purpose Mr Richard Cayzer, assistant, also spent some months making skins and cleaning skeletons for the Department of Ornithology and Mammalogy The writer left San Francisco May 27, 1930, for Nairobi, Kenya Colony, Africa, to join Mr Leslie Simson A stop was made en route to attend the annual meeting of the American Association of Museums at Buffalo, New York, and another at London, England, to purchase supplies While there I visited Cardiff, Wales, as the guest of the British Museums Association I arrived in Nairobi July 30, and left for America November 18 During this period I accompanied Mr Simson to many parts of Kenya, Tanganyika, and northern Rhodesia, and was successful in securing much needed material for the proposed African mammal halls This material includes 31 oil sketches for backgrounds, many plaster molds, detail sketches, photographs, and several tons of trees, shrubs, grasses, etc, for use as group accessories I returned to San Francisco December 25 Other work accomplished by the department has been the care of the specimens of African mammals received from time to time from Mr Simson To date these number 122 In addition to Mr Richard Cayzer, who has been employed thoughout the year, Mr Cecil Tose has been employed part time since September 1

FRANK TOSE, *Chief*

DEPARTMENT OF FISHES

1 *Work with the Indiana University Collection*

This great collection, estimated to include over 220,000 specimens, is partly stored in cartons containing the bottled material, and partly in tall well glazed crocks with tops that can be sealed on Of the material in the cartons about half the bottles have been removed, washed, new labels furnished where necessary, and in addition an assistant, who was hired merely to wash bottles, but was also a proficient typist, prepared a card-catalogue of all the specimens handled, indicating the number of the carton to which they were returned, and kept these cards in alphabetic order, so that as far as we have gone, with the exception of a few cartons that had previously been gone over, and the bottles washed and shelved, we know what species are in the collection and in which carton they are to be found This work will be of great value in subsequent assorting and arranging

The crock collection has needed looking over, as the contents and their condition is unknown for many of the crocks A good many have been found to contain unworked material from South America collected by Dr. Carl Ternetz I have assisted Mr Myers of Stanford University, to go over as many of these as have been opened, and we have assorted, bottled and added fresh labels to such material as needed it

2 *Work with Type Material*

In addition to the types already accumulated, more types keep turning up as the work progresses Additional shelves were built in the type room, all the types arranged in order, and a card catalogue prepared and arranged. It is desirable to have on each card for a type a reference to the original description By a search through the literature I have made some progress in this work, which has been laid aside for the present on account of the pressure of routine work.

3. *Work with the General Collection*

As occasion has required and opportunity permitted, I have gone over the general collection, noting condition and adding alcohol where needed The crock material needs especially assiduous attention as the crocks used are entirely unsuited to the purpose, the tops having no provision for sealing against evaporation, and the bottoms and sides of some so poorly glazed that liquid oozes through, allowing deterioration to proceed rapidly An attempt was made to assort, arrange and catalogue the California material It was necessary to divide this into two lots, one with well-authenticated data, and a mass of material marked "California" but without locality or date, and containing species not to be found within the state These may never have been intended for the Academy Museum This catalogue has enabled me to know just what species are needed for the collection, which I am attempting to build up as opportunities occur The names of specimens in the book-catalogue have most of them been entered in the card catalogue and their location indicated I am working at this whenever I have opportunity

4 *Biological Abstracts*

To this office comes all the manuscript of the part of Biological Abstracts pertaining to ichthyology, to be marked for the printer, and to it are referred all questions pertaining to position of genera, synonyms, and problems of indexing To answer these requires considerable search through the library The Biological Abstracts office kindly furnished cards containing every generic name to be found in Jordan's *Genera of Fishes* To be of use, each of the genera on these cards should have been dated, in order to distinguish synonyms, but this the Abstracts office overlooked These cards have been arranged in alphabetic order, and I have begun dating them, but this work has been laid aside temporarily on account of the pressure of routine. I am also attempting to keep this index of genera up to date by inserting new cards of a different color

The generic Catalogue of Jordan had been long outgrown, on account of the immense number of genera described since the year of its publication (1919) All American genera and species encountered have been added to the 1930 Check-list, both in an interleaved copy and its index, where some of the interleaved pages have been over-run, and to the loose sheet edition which has unlimited growth. The assistant librarian kindly turns over to me such exchanges as have to do with fishes, and I have

abstracted as many as time has allowed, many I have not had time to even glance at, although it is important to do so to keep track of present trends and discoveries in ichthyology The Check-list itself seems to have increased about ⅓ its volume since publication.

H WALTON CLARK, *Assistant Curator*

DEPARTMENT OF HERPETOLOGY

The months of January and February, and the first half of March, 1930, were spent completing a season's field work in Australia This work began in June, 1929, and the states of Queensland, New South Wales, Victoria, South and West Australia, were visited, resulting in a collection of 2577 specimens, many of the genera and most of the species being new to the collection Excellent series of some of the most unique of the Australian lizards are represented in the collection Unfortunately, it was found necessary in many cases to limit the series of the various species taken in order to conserve alcohol when far away from a base of supplies

During the months of May and June, San Diego Co, California, was visited for the purpose of taking motion pictures of our Californian rattlesnakes About 1000 feet of film has been made up, with instructive titles, depicting the various kinds of rattlesnakes found within the borders of the state, the habitats in which they live, and the method used in extracting the venom for the preparation of antivenin On this expedition 62 specimens were collected, including some of the rarer snakes of our southern deserts

While not absent in the field the routine work of the department was carried on as usual and 2829 specimens have been labeled, card catalogued and installed in the collection The Log of the schooner *Academy* on the expedition to the Galapagos Islands in 1905-1906 has been written up and presented for publication

Besides the material secured by exploration, gifts of specimens have been received as follows From L. S Slevin, 2, Russell V Fisher, 4, Dr E. C Van Dyke, 1, Chas Hibbard, 1, Dr Barton Warren Evermann, 1, J R Slater, 11, Chas Barnard, 14, H Trost, 10, Richard P Erwin, 2, G F Knowlton, 1, Kenneth Johnson, 1, S B Davidson, 3, L. M Klauber, 1 Through Mr L M Klauber 28 rattlesnakes were received by purchase from the Zoological Society of San Diego

The total number of specimens received during the year is 2719, the collection now numbering 66,722 specimens

The opportunity to secure the part-time services of Miss Enid Larson for cataloguing the department library was taken advantage of, with the result that the card catalogue of all of the separates and bound volumes has been completed to date

In connection with the expedition to Australia the thanks of the department are due the curators of the Australian Government Museums, who extended many courtesies, and particularly to Mr J R. Kinghorn and Mr H S Grant, of the Australian Museum at Sydney, for much

valuable assistance connected with the details of the field work. Thanks are also due Messrs Chas. Barnard, James Burns, Ben Chaffey, Chas. Craig, P C. Allan and many others too numerous to mention

For the expedition to San Diego County thanks are due Mr L. M. Klauber, the Zoological Society of San Diego and Mr L H Cook, without whose assistance the rattlesnake film could not have been made

Joseph R. Slevin, *Curator*

Department of Library

The principal job of the Academy Library in 1930 turned out to be the completion of the shifting of the bookstock and the making of a temporary shelf-list for all unrecorded titles, a great many of which were discovered during the former process The time necessary to sort and shelf-list them was so great that, together with the time required to shelve the congested current accumulations, it left none to be devoted to cataloguing proper On account of this as well, the upper library only could be relabeled

A handicap in the year's work was the loss early in the year of the clerical assistance which had been given formerly by the Aquarium typist. This loss has proved to more than balance the advantage of having a full-time library assistant in addition to the part-time presence of the assistant librarian, an arrangement which in itself, due to the additional revision of work necessarily involved, was not expected to increase the output of work in proportion to actual time put in

The chief present need of the Library is additional personnel The clerical routine required for making and preserving adequate records, such as have been installed during the past two years, is now so large that the present force is severely taxed in carrying both the routine and the technical operations like cataloguing and bibliographical research. The routine can not be neglected, so the more technical work suffers constantly This situation should be relieved at the earliest possible moment by the addition of clerical assistance

Accessions for the year were as follows.

	Bd vols.	Unbd vols.	Parts of vols	Pamphlets	Maps
Exchange . .	53	86	4313	84	184
Gift .. .	17	69	2780	841	7
Purchase	281	90	1251	210	21
Total	351	245	8344	1135	212

This is not counting the large donation of engineering publications from William Hammond Hall, which have not yet been sorted and counted Binding amounted to 261 volumes bound, rebound or repaired New exchanges added were 26

At the first of the year the assistant librarian began the arrangement of being present third-time, due to his undertaking graduate work in bibliography at the University of California. Miss May Peffer, formerly of the Western Union Telegraph Company library in New York, was employed full time as library assistant from the first of January, but unfortunately had to leave early in the month on account of illness Early in February Miss Veronica J Sexton, for a number of years an assistant in the Oakland Free Library, was engaged to take Miss Peffer's place. Miss Sexton's training and experience have proved distinctly valuable in the specialized work required in the Academy Library. Robert L. Thompson, Jr., was employed part time for several months the first part of the year to help in rearranging the shelves Mrs Barbara Cowles was employed for three weeks in December to sort the maps and to start a catalogue of them

In June the Special Libraries Association held its national convention in San Francisco The assistant librarian as president of the local chapter was chairman of the convention committee, and as a member of the Museum Group entertained informally both at the Academy and on trips to other museums in the city such museum librarians as had not attended the regular meeting of the Group held earlier in Buffalo at the convention of the American Association of Museums The following week the assistant librarian and Miss Sexton attended the meeting of the American Library Association in Los Angeles, in connection with which the annual meeting of the California Library Association was also held

In the late summer the assistant librarian was appointed to the editorial board of *Special Libraries* and named on a committee of the Museum Group of the national Special Libraries Association formed for the purpose of undertaking a survey of the libraries of art and science museums in this country during the forthcoming year In September the Academy Library was host to the local chapter of the Special Libraries Association, when the director gave a brief talk on the Academy's history and work and the guests visited the Museum groups, the Library and the Aquarium

Besides the need for added personnel, which was stressed above as being particularly urgent, there is no lessening of the need for more money for accessions and more space for housing them. It is a consummation devoutly to be wished for that funds may be obtained at no distant date for the construction and endowment of a new library as a unit in the Academy's plans for expansion No less than new quarters and ample financial support is adequate for the satisfactory functioning which the library must perform in an institution like the Academy, namely resources for the fundamental research of the staff, for the information and pleasure of the membership, and for the reference use of the community

Thomas Cowles, *Assistant Librarian*

DEPARTMENT OF ORNITHOLOGY AND MAMMALOGY

Work of the department during 1930 has been almost entirely in continuance of activities previously begun The only field work was inaugurated late in the year, Mrs Davidson, Assistant Curator, leaving on November 28 on a three months' trip to Chiriqui Province, Panama, for the further exploration of the region she had visited the previous winter

The Curator's study of the Academy's collection of Galapagos birds reached a point where it seemed essential that he examine the specimens in certain large European Museums, and he was absent on this quest from April 5 to July 8. Most of that time was spent in England, at the British Museum (Natural History), London, and at the Rothschild Museum, Tring, on the way home a short stay was made in Washington, D C., for similar studies at the United States National Museum The report upon the avifauna of the Galapagos Archipelago was finished late in the year and the manuscript accepted for publication and turned over to the printer in December

During the European trip above-mentioned advantage was taken of the opportunity to attend the Seventh International Ornithological Congress, held at Amsterdam, June 1 to 8 The Curator acted as delegate from the Academy and also from the United States Department of Agriculture, the American Ornithologists' Union, and the Cooper Ornithological Club

Mrs Davidson's time, as in previous years, has been mainly occupied in the details of office routine As opportunity offered she has pursued the study of her previous collection of birds from Panama, and the further completion of Mr Loomis's unfinished "Monograph of the Tubinares"

Mr Joseph Mailliard, Curator Emeritus, has continued the banding of birds at Woodacre, Marin County, and to a limited extent in Golden Gate Park In November the Academy published his "Handbook of the Birds of Golden Gate Park," a pocket manual that has been most favorably received and that appears to be filling an expressed need of the amateur bird students of this section

The Curator and Assistant Curator continue to act as inspectors of foreign birds and mammals for the United States Department of Agriculture This necessarily takes some time, entailing as it does the examination of all live foreign animals, mostly birds, brought in at the port of San Francisco, but it has proved worth while in several ways Interesting birds sometimes die, to the enrichment of our collection. During the past year we thus acquired three specimens of the rare Mikado Pheasant, from the island of Formosa, a species that is probably not represented in any other North American Museum

Accessions during the year were mostly of small lots of specimens, about 600 birds and 400 mammals all told Mrs Davidson returned from Panama in January, 1930, with 366 birds, the largest single accession of the year Mr G Frean Morcom, of Los Angeles, who had already given us his entire collection of North American birds, this year

presented us with a series of 92 Hummingbirds, representing about 75 species, mostly from South America and nearly all new to the Academy collection. In view of the lessened field work of our own collectors the opportunity was seized to purchase a collection of 340 mammals from Arizona and southern California, nearly all of species new to our collection, and especially valuable in the inclusion of a large number of topotypes.

The annual meeting of the Cooper Ornithological Club, held in Los Angeles during the first week in April, was attended by all members of the Department of Ornithology, Mr Mailliard, Mr Swarth and Mrs Davidson, as well as by Dr Barton Warren Evermann Papers were read by Mr Swarth and Mrs Davidson

The needs of the Department have been indicated in reports for the years immediately preceding and need not be dwelt upon here as there has been no change in conditions.

Details of the accessions are as follows Birds *Gift* Anonymous, 1, A. M Bailey, 1, Mrs. H Barkan, 1, C R Boatright, 5, D B Bull, 1, S Davidson, 7, Mrs. F. Ellsworth, 1, W Otto Emerson, 1, Fleishhacker Zoo, 1, E. W Gifford, 2, Graham Heid, 1, C W Hibbard, 2, E. C Jacot, 2, H E Jager, 4, G A. Jordan, 11, C. E Kruger, 2, C. C McGettigan, 5, John McLaren, 3, C. C. Moore, 1, G Frean Morcom, 92, Mori Bird Company, 2, D C. Peters, 1, Miss Muriel Pettit, 1, J H Pierce, 1, A L. Reed, 1, A W Robison, 1, J E. Stansfield, 1, J W Steinbeck, 8, F Sterling, 1; H S. Swarth, 1, Miss A B Titus, 1, E Walther, 1 *Expeditions* M E. Davidson, 366 *Purchase* 34 *Exchange* 5

Eggs. *Gift* J W Classen, 1 set; Mrs William Murphy, 8 sets *Purchase* 23 sets

Mammals *Gift* Miss J Alexander, 1, F N Bassett, 7, B Downes, 1, Dr G. Dallas Hanna, 1, Hooper Foundation, 1, Horne's Zoological Arena, 1, Joseph Mailliard, 2, John McLaren, 1, K F Meyer, 1, Mrs J Speck, 1, W W Thompson, 1 *Purchase* 340

HARRY S SWARTH, *Curator*

DEPARTMENT OF PALEONTOLOGY

The personnel of the Department remained practically unchanged from the previous year Dr L. G Hertlein continued as Assistant Curator except for several months which he spent in Alberta in geological exploration for the Hudson's Bay Oil & Gas Company Dr F. M Anderson, as Research Assistant, carried on his studies of the West American Cretaceous without interruption Mr J L Nicholson, student assistant, spent as much time at the Academy as he had free from his studies at the University of California, and Mrs Winifred Morrison, temporary assistant, did general clerical work in the Department about half time, throughout the year The faithful service rendered by all these associates deserves the highest commendation

Through the necessary curtailment of new collections because of lack of adequate storage facilities, exploration was confined to the securing of material urgently needed for studies already being prosecuted Some very valuable material was added from the Cretaceous through the efforts of Messrs Anderson, Nicholson and the Curator, and a beautiful collection of fossils of the same age was obtained in Alberta by Dr Hertlein Through the kindness of Messrs Wayne F Loel and William H Corey a nice collection of fossils of lower Miocene age has been added to the Academy's collections. Many of these are paratypes and have been placed in the type collection About 400 species of living marine shells were added from dredging operations conducted near Catalina Island, Point Conception, and Monterey, through the efforts of Mr Nicholson, Mr C. C Church, Mr. Allyn G Smith, and the Curator Many of these were small forms, needed for comparative purposes in connection with the series of studies being made of the West Mexican mollusks by Messrs Baker, Hanna and Strong Through the efforts of Mr C C Church, the Curator, and other employees of the Associated Oil Company, a very considerable amount of microscopical paleontological material was added during the year Fortunately, this requires very little space for storage.

The routine work of the Department has consisted in the systematic and orderly arrangement of the collections, always with the conservation of space foremost in mind At the end of the year the land shell collection had been completed in a very satisfactory manner and much progress had been made with the freshwater and marine shells

The scientific literature required for the maintenance of a collection so varied in character as that placed in the care of the Department is extremely large, and with the limited funds available for purchase of published papers, no hope can be held for securing all that are needed Nevertheless, through the constant interest of Dr. Evermann and Mr Cowles, some extremely useful books and papers were obtained in 1930

Numerous workers in various parts of the country have made use of the Academy's collections either through borrowing specimens or coming to the building for consultation. A list of all who have thus been helped would be too long to include here, but it may be well to record here those who had not yet returned loaned material at the end of the year

S S Berry, Redlands, California, Chitons Bryant Walker, Detroit, Michigan, Chinese land shells Nellie M Tegland, University of California, Oregon fossils Fred Baker and A. M Strong, Gulf of California shells A. Hollick, New York Botanical Garden, New York, Fossil plant H McMillan, Natural History Museum, Stanford University, California, Recent shells A G Smith, Berkeley, California, Land shells F. E Turner, University of California, Berkeley, California, Fossil shells P Bartsch, National Museum, Washington, D C., Recent shell

G DALLAS HANNA, *Curator*

Department of Steinhart Aquarium

On December 31, 1930, the number of species and live individuals of each on exhibition in the Aquarium was as follows

	Specimens		*Species*		*Specimens*		*Species*	
Mammals	11	of	3	as compared with	11	of	3	in 1929
Birds . .	4	of	3	as compared with	1	of	1	in 1929
Reptiles	209	of	37	as compared with	208	of	33	in 1929
Fishes	9196	of	324	as compared with	9375	of	282	in 1929
Batrachians	47	of	18	as compared with	53	of	9	in 1929
Invertebrates	360	of	45	as compared with	41	of	31	in 1929
Total	9827	of	430	as compared with	9689	of	359	in 1929

While this shows some increase both in specimens and species, we call attention to the fact that we have about reached the limit to the number of specimens that can be well exhibited with our present available space

It is therefore with pleasure that we call attention to the fact that the matter of a substantial addition to the Aquarium has been taken up by President Grunsky with the Board of Supervisors, and we feel confident that with the help of the many friends of the Aquarium the proposition will be brought to the attention of the people and favorable action taken The need for larger tanks, and additional space for invertebrates, as well as for better located vivariums, is quite evident

Gifts presented to the Aquarium in 1930 number 1376 A complete list of the donors, together with all matters of detail is presented in the body of the report The attendance during the year, as usual, has been very satisfactory

ALVIN SEALE, *Superintendent*

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7 Diatoms from the Kreyenhagen [Cantua] Shale [Abstract] <Pan-American Geologist, vol 54, no 1, Aug , 1930, p 80 [From program of Cordilleran Section, Geological Society of America, Feb 20-22, 1930]

8 Silicoflagellates from the Kreyenhagen [Cantua] Shale [Abstract] <Pan-American Geologist, vol 54, no 1, Aug , 1930, pp 79-80 [From program of Cordilleran Section, Geological Society of America, Feb 20-22, 1930

9 Abstract Vlerk, I M van der and R E Dickerson ' Distinctions among certain genera of larger Foraminifera for the field geologist of the East Indies " Journ. Paleo , vol 1, no. 3, 1927, pp 185-191, 3 text figs. <Biol Absts , vol 4, no 4, Apr , 1930, p 1257

10 Abstract Dall, William Healey and Washington Henry Ochsner Landshells of the Galapagos Islands Proc Calif Acad Sci , ser. 4, vol 17, 1928, pp 141-185, 2 pls , June 22, 1928 <Biol Absts vol 4, no 4, Apr , 1930, p 1267

11 [Report of] Department of Paleontology [for 1929] <Proc. Calif Acad Sci , ser 4, vol 18, no 18, Apr 8, 1930, pp 558-560, bibliography pp. 562-564

12 Abstract Skvortzow, B. W Freshwater diatoms from Ancoy, South China China Journ vol 11, no 1, July, 1929, pp 40-44, 1 pl <Biol Absts vol 4, no 5, May, 1930, pp 1524-1525

13 [Research on fossil diatoms] Abstracted in mimeograph form by David White in App P to Report of Committee on Paleobotany Nat Res Council, Div Geol and Geog May 3, 1930, pp 1-10, [see pp 6, 7, 9]

14 Abstract Zalessky, M D Premieres observations microscopiques sur le schiste bitumineux du volgien inferieur Soc Geol du Nord Ann 51, 1926 [1927], pp 65-104, pls 2-6 <Journ Paleo vol 4, no 2, June, 1930, pp 202-203

15 A Review of the Genus *Rouxia* <Journ Paleo vol 4, no 2, June, 1930, pp 179-188, pl 14, figs 1-8

16 Observations on *Lithodesmium cornigerum* Brun <Journ Paleo vol 4, no 2, June, 1930, pp 189-191, pl 14, figs 9, 10

17 The Growth of *Omphalotheca* <Journ Paleo vol 4, no 2, June, 1930, p 192, pl 14, fig 11

18 Marine Mollusca of Guadalupe Island, Mexico A M Strong & G Dallas Hanna <Proc Calif Acad Sci , ser 4 ,vol 19, no 1, June 4, 1930, pp 1-6

19 Marine Mollusca of the Revillagigedo Islands, Mexico A M Strong & G Dallas Hanna <Proc Calif Acad Sci , ser 4, vol 19, no 2, June 4, 1930, pp 7-12, June 4, 1930

20 Marine Mollusca of the Tres Marias Islands, Mexico A M Strong & G Dallas Hanna <Proc Calif Acad Sci , ser 4, vol 19, no 3, June 4, 1930, pp 13-22

21 Rediscovery of *Polygyra roperi* Pilsbry G Dallas Hanna & J L Nicholson <Nautilus, vol 44, no 1, July, 1930, pp 17-18

22 Porosity of Diatomite <Engineering and Mining Journal, vol 130, no 1, July 10, 1930, pp 7-8, 7 text figs

23 Geology of Shark Tooth Hill, Kern County, California <Proc Calif Acad Sci , ser 4, vol 19, no 7, July 15, 1930, pp 65-83, 3 text figs.

24 Some Mollusca of the family Epitoniidæ from the Gulf of California F Baker, G Dallas Hanna & A M Strong <Proc Calif Acad Sci , ser 4, vol 19, no 5, July 15, 1930, pp 41-56, pls 2, 3

25 Some Rissoid Mollusca from the Gulf of California Fred Baker, G Dallas Hanna & A. M Strong <Proc Calif. Acad Sci , ser 4, vol. 19, no 4, July 15, 1930, pp 23-56, pl 1, 4 text figs

26. The dates of publication of Tempere and Peragallo's "Diatomees du Monde Entier," Edition 2 <Journ Paleo , vol 4, no 3, Sept , 1930, pp 296-297

27 Hyrax, a new mounting medium for diatoms <Journ. Royal Micr Soc , ser 3, vol 50, pt 4, Dec , 1930, pp 424-426

28 Remains of Holothuroidea from the Carboniferous of Kansas <Journ Paleo , vol 4, no 4, Dec , 1930, pp. 413-414, pl 40, figs 1-7

29 A new genus of Silicoflagellata from Lower California <Journ Paleo , vol 4, no 4, Dec , 1930, pp 415-416, pl 40, figs 8-18

Howell, John Thomas

1 Plantæ Occidentales—I <Madroño, vol 2, no 1, pp 11-15, August 30, 1930

Mailliard, Joseph

1 Decrease of Nuttall Sparrow Population in Golden Gate Park <The Gull, vol 12, no 2, pp 1-2, February, 1930

2 Census of Birds' Nests in the Music Concourse, Golden Gate Park, San Francisco, California, for 1929 <The Gull, vol 12, no 3, pp 2-3, March, 1930

3 Happenings in a Robin Household <The Condor, vol 32, no 2, pp 77-80, March 15, 1930

4 Western Robin eating Ivy Berries <The Condor, vol 32, no 4, p 210, July 15, 1930

5 The Birds of Golden Gate Park, San Francisco Special Pub , Calif Acad Sci , pp 1-84, 95 text figures, November 20, 1930

Seale, Alvin

1 Constructing, Stocking, and Planting Small Fish Ponds or Garden Pools <Aquarium Journal, vol 3, pp. 3-5, January 2, 1930

2 The Exhibit of Invertebrate Animals at Steinhart Aquarium <Aquarium Journal, vol 3, p 14, March 6, 1930

3 The Montana Grayling, *Thymallus montanus*, in California <California Fish and Game, vol 16, p 51, January, 1930 (Copied in Du Pont Magazine and Montana Wild Life)

4 Fishes in Steinhart Aquarium from the Fiji Islands <Aquarium Journal, vol 3, p 21, April 3, 1930

5 Shark at Steinhart Aquarium Lay Eggs on Easter Sunday <Aquarium Journal, vol 3, p 24, May 1, 1930

6 Bibliography of Amphibia <Aquarium Journal, vol 3, p 26, May 1, 1930

7 Notes Regarding Steinhart Aquarium. <Aquarium Journal, vol 3, pp 36-37, September 4, 1930

8 List of Twenty Fresh Water Fishes found in California that may be used in small Aquariums or Garden Pools <Aquarium Journal, vol 3, pp 38-39, September 4, 1930

9 Feeding Young Fish <Aquarium Journal, vol 3, p 43, October 2, 1930

10 Literature on Fish Foods and Feeding <Aquarium Journal, vol 3, pp 44-45, October 2, 1930

11 The Sea Hare, *Tethys californica*, at Steinhart Aquarium <Aquarium Journal, vol 3, p 45, October 2, 1930

12 Live Sea Anemones shipped from Steinhart Aquarium to Australia <Aquarium Journal, vol 3, p 48, November 2, 1930

13 The Balanced Salt Water Aquarium <Aquarium Journal, vol 3, p 49, November 2, 1930

14 Bibliography of Goldfishes <Aquarium Journal, vol 3, p 55, December 4, 1930

15 [Annual Report] Department of Steinhart Aquarium [for the year 1929] <Proc Calif Acad Sci, ser 4, vol 18, no 18, pp 560-561, April 8, 1930

Slevin, Joseph R

1 [Report], Department of Herpetology [for 1929] <Proc Calif Acad Sci, ser 4, vol 18, no 18, pp 554-555, April 8, 1930

2 Contributions to Oriental Herpetology, X Korea or Chosen <Proc Calif Acad Sci, vol 19, no 10, pp 105-108, July 15, 1930

3 Further Notes on the Genus *Ensatina* in California <Copeia, no 3, pp 77-78, September 30, 1930

4 A Note on the Discovery of the Genus *Typhlops* in the Hawaiian Islands <Copeia, no 4, p 158, December 31, 1930

Swarth, Harry S

1 [Report] Department of Ornithology and Mammalogy [for 1929] <Proc Calif Acad Sci, ser 4, vol 18, no 18, pp 556-558, April 8, 1930

2 Notes on the Avifauna of the Atlin Region, British Columbia <Condor, vol 32, no 4, pp 216-217, July 15, 1930

3 Nesting of the Timberline Sparrow <Condor, vol 32, no 5, pp 255-257, 1 text fig, September 15, 1930

4 [Biographical notice of] Frank Aleman Leach <Auk, vol 47, no 2, pp 308-309, April, 1930

Tose, Frank

1 [Annual Report] Department of Exhibits [for 1929] <Proc Calif Acad Sci, ser 4, vol 18, no 18, April 8, 1930

2 Technical Section of the American Association of Museums announces program and asks help of museum preparators, also open letter from the Chairman <Museum News, vol 7, no 8, October 15, 1929

3 Comments upon the habitat groups in the California Academy of Sciences <Museum News, vol 7, no 10, November 15, 1929

4 Reproducing wet earth <Museum News, vol. 7, no. 15, February 1, 1930

5 The Scale Model Group <Museum News, vol 7, no 18, March 15, 1930

Van Duzee, E P

1 [Report] Department of Entomology [for 1929] <Proc Calif. Acad Sci, ser 4, vol. 18, no 18, pp. 550-552, April 8, 1930

2 Book Reviews (Wright, List of Butterflies of San Diego Co, Calif, Hussey, General Catalogue of the Hemiptera, Pyrrhocoridæ) <Pan-Pacific Entomologist, vol 6, p 144, March 15, 1930

3 A New Empoasca. <Pan-Pacific Entomologist, vol 6, no 4, p 148, May 3, 1930

4 Concerning Scientific Names <Pan-Pacific Entomologist, vol 6, no 4, p 166, May 3, 1930

5 Book Review (Comstock's Manual for the Study of Insects, new edition) <Pan-Pacific Entomologist, vol 7, no 1, p 4, September 26, 1930

6 (Note on) *Lepidomys irrenosa* Guenée <Pan-Pacific Entomologist, vol 7, no 1, p 8, September 26, 1930

7 Necrology, Dr William Barnes <Pan-Pacific Entomologist, vol 7, no 1, p 16, September 26, 1930

8 A New Bedunia <Pan-Pacific Entomologist, vol 7, no 2, p 64, December 12, 1930

9 Book Review (Brookings Institution Service Monograph No 60 United States Bureau of Entomology) <Pan-Pacific Entomologist, vol 7, no 2, p 69, December 12, 1930

10 (Note on) The Norman R Gunn Collection of Butterflies <Pan-Pacific Entomologist, vol 7, no 2, p 72, December 12, 1930

11 Editorial Comment (on stability of Nomenclature) <Pan-Pacific Entomologist, vol 7, no 2, p 96, December 12, 1930

Acknowledgments

The number of those who in the past year have donated valuable specimens to the Museum or the Aquarium, or who have assisted the Academy in other ways, has been large To all who have shown their interest in the Academy in these or other ways, and their appreciation of what the Academy is doing for the public and for science, grateful thanks are given. The research collections in every department have been enriched by the many large and valuable collections which have been received The educational value and the beauty of the Aquarium

has been enhanced by the many donations of specimens by friends

Special mention should be made of the courtesies extended to the Academy by the Southern Pacific Company, the Atchison, Topeka and Santa Fe Railway System, the Matson Navigation Company, and the Los Angeles Steamship Company Each of these companies continues to assist the Academy by supplying reduced transportation to members of the staff when engaged in scientific research in the field

NEEDS OF THE MUSEUM

The needs of the Museum are many Perhaps the most important of the urgent needs is that of new buildings We need more than double the space we now have for our research collections and our research work Thirty-two large metal herbarium cases, every one filled with specimens of inestimable value, are out in the hall of the second floor of the Research Wing The departments of entomology, paleontology, and ornithology and mammalogy, are as badly congested, each has much of its research or reference material stored in the basement, placed out in the halls, or in cases stacked so high as to be very difficult of access The Library is suffering very seriously because of lack of room It is not possible to arrange the books and pamphlets as they should be, nor is it possible to classify and store our duplicates properly

The Academy's stock of its own publications (Proceedings and Occasional Papers) now fills the janitor's room in the Research Wing, much of the Check-room, and most of the hall on the lower floor of the Research Wing, a condition intolerable and rendering the proper care and safety of the books impossible

In addition to all this there are many collections and individual specimens of educational interest stored in the basement where they cannot be made available for display or any other purpose.

The proposed East Wing upon which construction work is expected to begin early this year, will relieve this condition to some extent, as it is the intention to transfer to the new building the departments of Entomology and Ichthyology, and the

Offices of Administration. This will relieve the space now occupied by those departments and make it available for the departments that remain in the West Wing.

The second great need is more room for public exhibition purposes The third pressing need is a modern up-to-date auditorium

Accessions for the Year 1930

Department of Botany

Anderson, Frank M , California Academy of Sciences, San Francisco 10 specimens of plants from Colombia, South America Gift

Arnold Arboretum, The, Jamaica Plain, Massachusetts 211 specimens of trees and shrubs from Kew, England Exchange

Augsbury, Mrs John C , 3799 Washington Street, San Francisco 12 botanical specimens from Indio, California Gift

Branson, Ivan, 1290 Hayes Street, San Francisco 26 botanical specimens from Kit Carson Pass, California Gift

Donat, Dr Tehuelches—F C E , Gob, Santa Cruz, Argentina 100 botanical specimens from Argentina Purchase

Eastwood, Miss Alice, California Academy of Sciences, San Francisco 187 botanical specimens from Arizona and 144 from California, 11 botanical specimens from Panama Exploration

Follett, Mrs W I , 157 Ronado Street, Oakland, Calif 11 botanical specimens from Plumas County, California Gift

Grant, J M , Marysville, Washington 29 specimens of plants from Marysville, Washington. Gift

Hart, Cecil, 132 N 3rd Street, Montebello, California 55 botanical specimens from California Gift

Hilend, Miss Martha, University of California at Los Angeles 14 specimens of California plants Gift.

Hoffmann, Ralph, Santa Barbara Museum, Santa Barbara, California 276 botanical specimens from the Channel Islands and southern California, 86 specimens of California plants Gift

Howell, John Thomas, California Academy of Sciences, San Francisco 5,310 specimens of California plants, 2,907 specimens of plants for exchange. Gift 500 specimens of California plants Exploration.

Jackson, Belle R, San Rafael, California 30 specimens of California plants Gift

Jones, Katherine D, University of California, Berkeley, Calif 15 specimens of exotic plants Gift

Jones, Marcus, Pomona College, Claremont, Calif 561 specimens of western plants Purchase

Jussel, M S, 473 45th Street, Oakland, Calif 440 specimens of California plants Gift

Keck, David D, Carnegie Laboratory, Stanford University, Calif 21 specimens of plants from western states Gift

Kelly, Isabel T, Museum of Anthropology, Berkeley, Calif 71 specimens of California plants Gift

Kramer, A W, Susanville, California 38 botanical specimens from Lassen National Park Gift

Larson, Enid, California Academy of Sciences, San Francisco 11 specimens of California plants Gift

Mexia, Mrs Ynez, Berkeley, Calif 100 botanical specimens from Mexico Purchase

Peirson, Frank M, 1077 New York Avenue, Altadena, California 90 specimens of California plants Gift

Phelps, Mrs Kate E, California Academy of Sciences, San Francisco 27 botanical specimens from St Helena, California Gift

Rose, Mrs C F, 1444 Chestnut Street, San Francisco 19 California plants Gift

Rose, Lewis S, 2165 Jackson Street, San Francisco 165 specimens of California plants Gift

Sutliffe, Mrs E C, 700 Lake Street, San Francisco 39 specimens of Hepaticæ Gift

University of California, Berkeley, California 352 specimens of California plants Exchange

University of Montreal, 1265 Rue Sainte-Denis, Montreal, Canada 556 specimens of Canadian plants Exchange

Van Dyke, Mrs Edwin C, 2440 Stuart Street, Berkeley, Calif. 472 specimens from the western states, botanical Purchase

Venturi, S, Tucuman, Argentina 328 botanical specimens from Argentina Purchase

Walther, Eric, Golden Gate Park, San Francisco 475 specimens of exotic plants Gift

Wolf, Carl B, Stanford University, Palo Alto, California 941 botanical specimens from the western states and Mexico Purchase

DEPARTMENT OF ENTOMOLOGY

Barrett, Ralph E, Saticoy, Calif 162 miscellaneous insects Gift

Blaisdell, Dr F E, California Academy of Sciences, San Francisco 72 miscellaneous insects and 3 scientific publications Gift

Bryan, Edwin H, Bishop Museum, Honolulu, T H 275 insects from Pennsylvania Gift

Comstock, Dr John A, Los Angeles Museum, Exposition Park, Los Angeles, Calif 13 moths (*Lithoprosopus coachella* and *Gloveria dolores*) Gift

Davidson, Mrs M E, California Academy of Sciences, San Francisco 48 miscellaneous insects from Panama Gift

Dodge, E A, Santa Cruz, Calif 403 Lepidoptera, including a named series of skippers (Hesperidæ) Gift

Gunn, Mrs Joseph, Berkeley, California A collection of 3,300 butterflies prepared by the late Norman Gunn Gift

Heid, Graham, 1239 Bay Street, Alameda, California 63 butterflies from Japan Gift

Knowlton, G F, Utah Agricultural Experiment Station, Logan, Utah· 98 miscellaneous insects from Utah. Gift.

Light, Dr S F, University of California, Berkeley, Calif 30 miscellaneous insects from Lower California Gift

Leach, Mr E R, 117 Hillside Avenue, Piedmont, Calif 28 miscellaneous insects Gift

Martin, J O, California Academy of Sciences, San Francisco 5,540 miscellaneous insects from Texas and Arizona Exploration

Slevin, Joseph, California Academy of Sciences, San Francisco 430 miscellaneous insects from Australia Gift

Slevin, L S, Carmel, Calif 1032 insects from Carmel, Calif Gift

Smith, H M, Singapore, Siam, through Dr B W Evermann· 119 insects, mostly butterflies from Siam Gift

Strohbeen, J B, Santa Cruz, California 39 miscellaneous insects from Oregon Gift

Swarth, George, California Academy of Sciences, San Francisco 990 miscellaneous insects, largely butterflies, from Atlin, B C Purchase

Swarth, Morton, California Academy of Sciences, San Francisco 70 butterflies from Atlin, B C Gift

Timberlake, Dr P H, Citrus Experiment Station, Riverside, Calif 227 bees, mostly paratypes in genus Perdita Gift.

Van Duzee, E P, California Academy of Sciences, San Francisco 1320 miscellaneous insects from the Sierra foothills, 743 insects from Inyo and Mono counties, California Exploration

Van Duzee, M C, Buffalo, New York 25 moths from Cattarangus County, New York Gift

Van Dyke, Dr E C, University of California, Berkeley, California 2854 insects other than Coleoptera, from Rocky Mountain Region, 248 insects from Sequoia National Park, California Gift

Wright, W S, San Diego Society of Natural History, San Diego, Calif 48 miscellaneous insects from San Diego County, Calif Gift

Zschokke, T O, Palo Alto, Calif 2510 miscellaneous insects from Panama Purchase

Zimmerman, E C, 9422 Foothill Blvd, Oakland, California 10 beetles from Pangal, Chili Gift

Department of Exhibits

Fleishhacker Zoo, San Francisco 1 female Chimpanzee Gift

Johnson, Mrs Martin, 651 Alvarado Street, San Francisco 1 mounted male Japanese Pheasant (*Phasianus versicolor*) and 1 artifact Head and body of Copper Pheasant (*Phasianus soemmerringi*), tail of Japanese Pheasant (*Phasianus versicolor*) Gift

McAllister, M Hall, California Academy of Sciences, San Francisco 11 mounted specimens, as follows 1 Wood-duck, 1 California Quail, 1 Mountain Quail, 1 Brant Goose, 1 Sage Hen, 1 Mallard Duck, 1 Deer Head, 4 sets of Deer antlers Gift

Stoney, Mrs George M, 2660 Scott Street, San Francisco, California 1 mounted head of American Bison Gift

Department of Fishes

Anonymous 1 dried Pinecone Fish (*Monocentrus japonicus*) from Japan Gift.

Australian Museum, Sydney, Australia 1 specimen of *Neoceratodus forsteri* Günther Exchange

Campbell, Berry, 138 North Poppy Street, Monrovia, California 4 specimens of *Temeculina orcutti*, from Crystal Lake, Los Angeles County, California Gift

Davidson, Mrs. Mary E McLellan, California Academy of Sciences, San Francisco 1 shark (*Carcharias lamiella*) from San José de Guatemala, Jan 17, 1930 Gift

Gudger, E W, American Museum of Natural History, New York City, New York 10 specimens including 7 species of South American fishes. Gift

Hildebrand, S F, Beaufort, North Carolina 1 *Lobotes surinamensis* from Newport River, Beaufort, N C, and 3 specimens of *Pomatomus saltatrix* from Beaufort Harbor, N C Gift

Laycock, H, Rosario Mines, San Juancito, Honduras 1 Four-eyed Fish (*Anableps dowii*) Gift

Reid, J T, Oroville, Butte County, California 2 Small-mouth Black Bass (*Micropterus dolomieu*) from Tuttle Lake, Placer County, Calif Gift

Rougier, Emmanuel, Christmas Island, South Pacific Ocean 20 small fishes including 13 species Gift

Steinhart Aquarium, San Francisco 13 specimens of fishes including 12 species Gift

United States Bureau of Fisheries, Grand Station, Louisiana 2 specimens of *Lobotes surinamensis* taken about 5 miles off Grand Terre, Louisiana, in open sea Gift

Department of Herpetology

Barnard, Charles, Queensland, Australia 11 frogs, 1 lizard, 2 snakes from Queensland, Australia Gift

Davidson, S B, Route 7, Box 635, Ft Worth, Texas 1 lizard (*Phrynosoma cornutum*) and 2 toads, spec ? from Ft Worth, Texas Gift

Erwin, Richard P, Boise, Idaho 2 Rattlesnakes (*Crotalus c lutosus*) 15 miles south of Boise Gift

Evermann, Dr Barton Warren, California Academy of Sciences, San Francisco 1 salamander (*Triturus torosus*) from Papermill Creek, Marin County, California Gift

Fisher, Russell, Lake Maxinkuckee, Indiana 4 Box Turtles (2 *Terrapene ornata* and 2 *Terrapene carolina*), from Lake Maxinkuckee, Indiana Gift

Hibbard, Charles W, Steinhart Aquarium, San Francisco 1 snake (*Crotalus oreganus*), from Coronados Islands, Mexico Gift

Hubbe, Mrs M S, Millbrae, California 1 Gopher Snake (*Pituophis catenifer*) Gift

Johnson, Kenneth, Sacramento, Calif 1 Gopher Snake (*Pituophis catenifer catenifer*) from Sacramento, California Gift

Klauber, L M, San Diego, Calif 1 lantern slide of Garter Snake, 1 lizard (*Cnemidophorus tessellatus stejnegeri*), from South Coronado Island, Lower California, Mexico Gift

Knowlton, G F, Utah Agricultural Experiment Station, Logan, Utah 1 lizard (*Uta stansburiana stansburiana*) from Hardup, Utah. Gift

San Diego Zoological Society (Through L M Klauber) 28 Rattlesnakes, from Arizona, 10 *Crotalus c confluentus*, 12 *Crotalus scutulatus*, 6 *Crotalus atrox* Purchase

Slater, J R, Tacoma, Washington 2 frogs (*Rana pretiosa*), from Davenport, Wash, 7 salamanders (*Plethodon intermedius*), from Green Gorge, Pierce County, Washington, 2 salamanders (*Ambystoma paroticum*), from Sol Duc Hot Springs, Clallam Co, Washington Gift

Slevin, Joseph, California Academy of Sciences, San Francisco 10 snakes and 38 lizards from San Diego, Riverside, and Imperial counties, California, 2571 reptiles and batrachians from Australia and 7 lizards from Pago Pago, Samoa Exploration 1 salamander (*Ensatina eschscholtzii*) from Carmel, California Gift

Sutkamp, Mrs A C, San Francisco 1 Galapagos Island Sea Iguana Gift

Trost, H, San Francisco 10 lizards (*Gerrhonotus caeruleus*), from Camp Meeker, Sonoma Co, California Gift

Van Dyke, Dr E C, University of California, Berkeley, Calif 1 lizard (*Plestiodon skiltonianus*) from Sequoia National Park, California Gift

DEPARTMENT OF LIBRARY

Academia Sinica, Shanghai, China 1 pamphlet Academia Sinica with its Research Institutes, 1929 Gift

Adams, Wallace, Philippine Bureau of Science, Manila, P I 1 pamphlet, 1 bound volume, and 27 periodicals Gift

American Gas Association, 420 Lexington Ave, New York, N Y 1 copy, Selected Bibliography of Articles on the Industrial Uses of Gas, by C George Segeler Gift.

Anderson, Frank M, California Academy of Sciences, San Francisco 1 pamphlet and 2 unbound volumes on paleontology and 1 serial Stanford University Bulletin, 5th Ser, No 98, July 31, 1930 Gift

Associated Oil Company, 79 New Montgomery Street, San Francisco 1 geological pamphlet Gift

Bailey, L G, Ithaca, New York 1 pamphlet Statements on the Systematic Study of Variables Gift

Baker, Frank Collins, University of Illinois, Urbana, Illinois. 7 pamphlets by Frank Collins Baker on paleontology Gift.

Baldwin, Charles W, Kuahina Drive, Honolulu, Hawaii 3 pamphlets by D D. Baldwin on Hawaii, and 2 periodicals Hawaii's Young People, May, June, 1900 Gift

Beloit College, Beloit, Wisconsin 1 calendar Mural Paintings at the Logan Museum, Beloit College Gift

Besuden, Miss H Dorothy, Librarian, University of Ohio 1 copy, California Academy of Sciences Proceedings, 3rd Series, Geology, Vol. 1, No 2 Gift

California Association of Nurserymen, The, 340 San Pedro Street, Los Angeles, Calif 1 volume Kruckeberg, Henry W George Christian Roeding, 1868-1928. Gift

California State Chamber of Commerce, Ferry Building, San Francisco 1 pamphlet A Survey of Economic Research and Sources of Data Regarding California, a reference catalogue and index Gift

Canadian National Parks Commission, Ottawa, Canada 4 pamphlets Waterton Lakes Park, Banff, Kootenay and Yoho National Parks, Jasper Trails, and Prince Albert National Park Gift

Church, C C, Associated Oil Company, San Francisco 1 pamphlet Program, Seventh Annual Meeting of the Pacific Section, Association of Petroleum Geologists, Los Angeles, 1930 Gift

Clark, H Walton, California Academy of Sciences, San Francisco 26 scientific periodicals Gift

Cleveland Museum of Natural History, Cleveland, Ohio 3 pamphlets Nature Trails in Cleveland, A Bit of Tanganyika, and Episodes of the Amundsen-Ellsworth Arctic Flights Gift

Collins, Ross A, 5th District, Mississippi, House of Representatives, Washington, D C 1 separate from the Congressional Record Gift

Consorzio Nazionale Produttori Zucchero 1 pamphlet Menozzi, Carlo Insetti Dennosi alla Barbabietola. Gift

Cornwall, Ira, William Head, Box 850, Victoria, B C, Canada 94 copies of California Academy of Sciences Publications. Gift

Cowles, Thomas, California Academy of Sciences, San Francisco 1 copy, Special Libraries, Vol 20, 1929 title page and index, 12 pamphlets, 16 serials on library work, and 31 numbers of periodicals. Gift

Crocker, C H , 602 Balfour Building, San Francisco 1 copy each of California Academy of Sciences Occasional Papers 13 and 14, Proceedings Vol XV, Nos 17 and 18, Vol XVI, Nos 1-24 and index, Vol XVIII, Nos 13-16 Gift

Davidson, Mrs M E , California Academy of Sciences, San Francisco 69 publications Gift

Eastwood, Miss Alice, California Academy of Sciences, San Francisco 3 pamphlets, 223 periodicals and 42 miscellaneous publications Gift

Emergency Conservation Committee, 3548 Tyron Avenue, New York, N Y 1 pamphlet Quinn, Davis The Antelope's S O S Oct , 1930 Gift

Espana-Calpe, S A , Madrid, Spain 1 map Mapa geologica de Espana, por M Faura y Sans Gift

Evermann, Dr Barton Warren, California Academy of Sciences, San Francisco 3 pamphlets, 2 periodicals, 342 parts of publications, and 243 separates Gift

Exposition Internationale de la Grande Industrie, Sciences et Applications de l'Art Wallon Ancien, Liége, Belgium 2 pamphlets on the Exposition Gift

Felippone, Dr Florentin, Uruguay, South America 2 separates Felippone, F Contribution à la Flora Bryologique de l'Uruguay (Revue Bryologique, 56 année, t II, fasc 3-4, 1929), Contribution à la Flora Mycologique de l'Uruguay (Annales de Crytogamie Exotique, t 1, fasc 1, 1928) Gift.

Fernald, M L , 14 Hawthorn Street, Cambridge, Massachusetts 2 scientific pamphlets Gift

Fritzen, Theophil Leonard, 3011 Jackson Street, San Francisco 159 copies of Proceedings of the California Academy of Sciences, 6 Occasional Papers, 8 pamphlets on National Parks, 1 pamphlet on Camp Sanitation and Housing, 8 indexes to the National Geographic Magazine Gift

Geiser, S W , Southern Methodist University, Dallas, Texas 1 excerpt Geiser, S W , Pioneer Lies in Unnamed Grave, Dallas Morning News, February 23, 1930, pg 3 Gift

Grand Canyon National Park 3 pamphlets McKee, Edwin D . Preliminary Check List of the Mammals of the Grand Canyon, Preliminary Check List of the Birds of the Grand Canyon, and Preliminary Check List of the Reptiles and Amphibians of the Grand Canyon Gift

Grunsky, Dr C E., President, California Academy of Sciences, San Francisco. 1 pamphlet of the International Mediterranean Research Association of Rome Gift

May 29, 1931

Hall, William Hammond, 3855 Jackson Street, San Francisco 8 boxes of miscellaneous publications on engineering Gift

Hanna, Dr G Dallas, California Academy of Sciences, San Francisco 1 bound volume, 8 serials, 2 photostats, 4 maps, 6 parts of volumes, 478 periodicals, 73 pamphlets, and 36 separates Gift

Harrison & Sons, Ltd, 44-47 St Martin's Lane, London, W C 2, England 2 chemical pamphlets Gift

Herrera, A L, Laboratoire d'Analyses Chimiques, Biologiques et Industriels, Ciudad de Mexico 1 separate Herrera, A L Sur l'Imitation des Chromosomes, etc Gift

Hertlein, Dr L G, California Academy of Sciences, San Francisco 1 pamphlet General Report on the Properties of the Alberta Pacific Consolidated Oils Limited, 1929, 1 copy, College Algebra, by William Benjamin Fite, 12 miscellaneous pamphlets Gift

Industrial Relations, California Department of, Sacramento, Calif 1 copy, Labor Laws of the State of California, 1929 Gift

Kelly, Mrs G Earle, Alameda, Calif 24 copies of California Academy of Sciences publications Gift

Kinsey, Alfred C, Waterman Institute for Scientific Research, Indiana University, Bloomington, Indiana 1 volume on Gall Wasps Gift

Koebele, Mrs Albert, Waldkirch, Germany 2 copies of a pamphlet Fr V Koch Albert Koebele, 1930 Gift

Lastreto, C B, 260 California Street, San Francisco Proceedings, C A S, 4th Series, Vol 17, Nos 11 and 12, Vol 18, Nos 4-16, and 67 pamphlets Gift

Lowell Observatory, Flagstaff, Arizona 1 astronomical pamphlet Gift

Mailliard, Joseph, California Academy of Sciences, San Francisco 1 copy, Bird News, Vol 1, No 2 (March-April, 1909), 1 copy, Bird News, Vol 1, No 2, 2 numbers of 3rd Series and 31 numbers of the 4th Series of the Proceedings of the California Academy of Sciences, Proceedings of the California Academy of Sciences, 3rd Series, Zoology, Vol IV, Nos 4 and 5 (2 copies), 4th Series, Vol I, pp 405-430, Vol II, Pt I, No 11, Vol III, pp 1-56, 73-264, 391-454, Vol IV, No 1-6; Vol V, No 1-4, 6, Vol VI, No 1-3, Vol VII, No 10-11, Vol. IX, No 6, Vol X, No 1-4, 1 copy Birds of Golden Gate Park Gift

McAllister, M Hall, California Academy of Sciences, San Francisco 1 copy, Official Guide Book to the New York Zoological Park, and 12 miscellaneous pamphlets Gift

McGuire, Ignatius, Princeton University, N J 1 separate Bull of the Geol Soc. of Amer , Vol 41, pp 181-227

Merriam, Dr C Hart 1 pamphlet Merriam, C Hart The New River Indians Tló-hom-tah'-hoi Gift

National Research Council, Washington, D C 1 unbound volume Gift

Needham, James G , Cornell University, Ithaca, New York 1 unbound volume Zoologia Sinica Series A Volume 2 Gift

Nielsen Company, Chicago, Illinois 1 pamphlet Nielsen Survey, Armstrong's Cork Machinery Isolation used by Cleveland Museum of Art Gift

Oppenheimer, Julius, 1262 Russ Building, San Francisco California Academy of Sciences Proceedings, Vol 2, pt 2, No 18 (2 copies), Vol 11, index, Vol 12, index (2 copies), Vol 13, No 27 & 28, index, Vol 14, No 1-20 (2 copies of 18, 19, 20), Vol 15, No 1-18 (2 copies of 1-11), Vol 16, No 1-18, 20-24, index, Vol 17, No 1-5, 7-12, Vol 18, No 4-12, Occasional Papers 11-12, 14-16, Constitution and By-Laws of Sept 5, 1925 Gift

Older, Benjamin, 1262 Russ Building, San Francisco, Calif Proc C A S , 4th Series, Index, Vol 17, Index Vol 18 and Vol 18, No 17, Vol 19, Nos 1-10 Gift

Palmer, Dr T S , United States Biological Survey, Washington, D C 1 copy, Officers and Committee of the American Ornithologists' Union, 1930 Gift

Peers, Susie M , California Academy of Sciences, San Francisco 241 periodicals The Business Woman and current issues of Science for 1930, 21 copies of Golden Gate Pathfinder, 1 pamphlet Deutsches Museum, Munich, Brief guide, official edition, 3 pamphlets; 1 pamphlet Inauguration of Robert Gordon Sproul as President of the University of California, October 22, 1930, Berkeley, 1 newspaper The Daily Californian, Berkeley, Calif., Wednesday, Oct 22, 1930 Gift

Pennsylvania Geological Survey, Harrisburg, Pennsylvania 1 pamphlet The resources of Pennsylvania in a nutshell, prepared by the Penna Geological Survey Gift

Phillips, Mabel E , California Academy of Sciences, San Francisco 2 pamphlets The Passion Play at Oberammergau, 1 pamphlet; 3 periodicals, 4 newspapers Gift

Riedy, Charles C , 28 Geary Street, San Francisco 323 separates, 141 parts of volumes, and 11 volumes, all on scientific subjects Gift

Rixford, G P , California Academy of Sciences, San Francisco 1 copy, The Journal of Heredity, V 21, No 3, March, 1930 Gift

Royal Packet Navigation Company, 444 Market Street, San Francisco 1 pamphlet on Java Gift

Sampson, W F, 15th Floor, 215 Market Street, San Francisco: California Academy of Sciences Occasional Papers No 15; Proceedings, Vol 16, No 15, Vol 17, Nos 1-7, 9-10, Vol 18, Nos. 4-9, 11, 14-16 Gift

Savage, Grace O 1 pamphlet Savage, Grace O Printed treasures in the library of the United States Naval Observatory Gift

Show, S B, Regional Forester, California Region, Forest Service, Ferry Building, San Francisco. 1 pamphlet S. B Show How the national forests of California benefit the state (U. S Agric Mis Pub. No. 82) 1930 Gift

Smith, Gertrude M., Department of Zoology, Univ of British Columbia, Vancouver, B C 1 pamphlet. Detailed Anatomy of Triturus torosus Gift

Society of California Pioneers, 5 Pioneer Place, San Francisco 2 reprints from the Condor, 5 pamphlets pertaining to early history of the Academy, C A S Proceedings, 1st series, 2 nos ; Proc 2nd series, 5 nos, representing 3 vols, Proc 3rd series, Mathematics-Physics, Vol I, Botany, Vol II, Nos 4 and 11, Zoology Vol I, Nos 2 and 3, Vol IV, Nos 4 and 5, Index to Vol IV, 3rd Ser Zoology, Vol I, No 1 and Title page and index to Vol II, parts of 14 volumes of the 4th series of the Proceedings, Occasional Papers Nos 5, 10, 11, Constitution and By-Laws, 1915, 1921, 1925, Memoriams to Benjamin B Redding and Dr Hans H Behr, 13 old publications of the California Academy of Sciences Gift

Southern California Academy of Sciences, Los Angeles, California 1 pamphlet on Lepidoptera. Gift

Special Libraries Association, 11 Nisbet Street, Providence, Rhode Island 1 pamphlet Special Libraries Association Information Bulletin, No 5 Gift.

Steinbeck, W P, Stockton, California California Academy of Sciences Proceedings, Vol 12, No 29, 30, Vol 15, No 1, Vol 17, No 3, Vol 18, No 12 Gift

Swarth, H S, California Academy of Sciences, San Francisco 54 publications on scientific subjects Gift.

Thompson, Robert L, Jr, 726 11th Avenue, San Francisco 10 pamphlets on the National Parks Gift

Tose, Frank, California Academy of Sciences, San Francisco: 1 copy of Science Gift

United Fruit Company, 17 Battery Place, New York, N. Y 1 book The Romance and Rise of the American Tropics, by Samuel Crowther. Gift

U S Bureau of Foreign and Domestic Commerce, San Francisco 1 unbound volume Tariff Act of 1930 Gift

University of California, College of Agriculture, Davis, California· Occasional Papers C A S XIII and XIV, Vol XI, No 9, Vol XIV, No 1, Vol XVI, No 19, Vol XVII 1, 2, 4, 5-7, Bulletin Dept of Geology, Univ of Calif, Vol 3 Gift

Vanadium Corporation of America, New York, N Y 1 pamphlet Petinot, N Vanadium additions improve steel Gift

Van Duzee, E P, California Academy of Sciences, San Francisco 41 scientific publications Gift

Van Oosten, John, in charge Great Lakes Fishery Investigations, U S Bureau of Fisheries 1 pamphlet Some fisheries problems on the Great Lakes, by Dr John Van Oosten (Reprinted from v 50, 1929 Trans of the American Fisheries Society) Gift

Ward, Rowland, 167 Piccadilly, London, W 1 1 pamphlet The Orleans natural history trophies Gift

Ward, Miss Shirley, 537 Bush Street, Mountain View, California 35 numbers of California Academy of Sciences, 4th Series, Proceedings, and 4 numbers of the Occasional Papers Gift

Willcutt, George B, Market Street Railway Co, San Francisco California Academy of Sciences Occasional Papers No 10, Vols 1 and 2, Proceedings, Vol 12, No 3 Gift

Windele, Annette, American Trust Company, 464 California Street, San Francisco Occasional Papers No 11-13, Constitution and By-Laws, 1925, 79 nos representing 9 vols of Calif Academy Sci Proc 4th Series Gift

Wisconsin Academy of Sciences, Madison, Wisconsin A large number of California Academy of Sciences Publications comprising numbers of the 2nd, 3rd, and 4th Series of the Proceedings and four Occasional Papers and three issues of the Constitution and By-Laws Gift

Yuhasz, Michael, Sr, Homestead, Pennsylvania 1 pamphlet on Czechoslovakia Gift

MISCELLANEOUS

Rixford, G P, California Academy of Sciences, San Francisco 1 brick from the Russian Station on Farallon Islands Gift

Van Valkenburgh, Peter, 45 Armanino Court, Oakland, California 1 Indian basket from Lassen County Gift

Department of Ornithology and Mammalogy

Alexander, Miss Jacklyn, 1198 Dolores Street, San Francisco 1 Orsted's Titi Monkey (*Saimiri orstedii orstedii*) Gift

Anonymous 1 Ashy Petrel (*Oceanodroma homochroa*) Gift

Bailey, A M, Chicago Academy of Sciences, Chicago, Illinois 1 Goshawk (*Astur gentilis gentilis*) from Germany Gift

Bailey, Bernard, San Marcos, California 340 mammals and 27 birds Purchase

Barkan, Mrs Hans, 3653 Jackson Street, San Francisco 1 Quetzal (*Pharomachrus mocinno*) Gift

Barker, Fred, Parker's Prairie, Minnesota 4 bird skins from Minnesota Purchase

Bassett, F N, 91 Merced Ave, San Francisco 7 mammals from Sonoma County, California Gift

Boatright, C R, 534 Eleventh Ave, San Francisco 2 Nicobar Pigeons (*Caloenas nicobarica*), 1 Bob-white (*Colinus virginianus*), 1 Copper Pheasant (*Syrmaticus sœmmerringi*), and 1 Wood Duck (*Aix sponsa*) Aviary specimens Gift

Bull, D B, Bethel, Alaska 23 sets of eggs and 1 bird skin from Argentina Purchase

Classen, J W, Menlo Park, California Eggs of Chachalaca (*Ortalis vetula mccallii*), 1/3 From aviary bird Gift

Davidson, Mrs M E, California Academy of Sciences, San Francisco 366 bird skins from Panama Exploration

Davidson, S, Route 7, Box 635, Ft Worth, Texas 7 bird skins from Alameda and San Mateo counties, California Gift

Downes, B, Route 5, Box 370A, Watsonville, Calif 1 Hoary Bat (*Nycteris cinerea*) from Santa Cruz County, California Gift

Ellsworth, Mrs E, Turlock, Calif 1 Cobalt Love-bird (*Melopsittacus undulatus*) Gift

Emerson, W Otto, Palm Cottage, Hayward, Calif 1 White-tailed Kite (*Elanus leucurus*) from Alameda County, California Gift

Fishes, Department of, California Academy of Sciences, San Francisco 1 South American Bat Transferred to Dept of Mammalogy

Fleishhacker Zoo, San Francisco 1 Cassowary (*Casuarius australis*) Gift.

Gifford, E W, Museum of Anthropology, University of California, San Francisco 1 Galapagos Dove (*Nesopelia galapagoensis*), 1 Dove (*Columba maculosa*) Gift

Hanna, Dr G Dallas, California Academy of Sciences, San Francisco 1 Wild Cat (*Lynx californicus*) Gift

Hedges, C F, Coolin, Idaho 4 Gray Ruffed Grouse (*Bonasa umbellus umbelloides*) from Idaho Purchase

Heid, Graham, 1239 Bay Street, Alameda, California 1 Bronzed Grackle (*Quiscalus quiscula æneus*) from Illinois Gift

Hibbard, Charles W, Steinhart Aquarium, San Francisco 1 Nuttall Sparrow (*Zonotrichia nuttalli*) from San Francisco, 1 Egret (*Casmerodius egretta*) from Glenn County, California, 1 Great Blue Heron, female Gift

Holm, A, Redwood City, California 1 Kangaroo Rat (*Dipodomys heermanni goldmani*), 1 California Shrew Mole from the south arm of Portola Valley, San Mateo County, California Gift

Hooper Foundation for Medical Research, Affiliated Colleges, San Francisco 1 Gibbon (*Hylobatus*, sp ?) Gift

Horne's Zoological Arena Co, Altadena, Calif 2 Malay Squirrels (*Sciurus erythræus*) Gift

Jacot, E C, P O Box 462, Prescott, Arizona 2 Azure Bluebirds (*Sialia sialis fulva*) from Arizona Gift

Jager, H E, 256 Hanover Ave, Oakland, Calif 1 Macaw (*Ara macao*), and 3 Tovi Paroquets (*Brotogeris jugularis*), aviary specimens Gift

Jordan, G A, Jordan Game Farm, R F D 1, Woodland, Calif 2 Mikado Pheasants (*Syrmaticus mikado*), 2 Cabot's Tragopan (*Tragopan caboti*), 2 Chukars (*Alectoris græca*), 1 Cinereous Tinamou (*Nothoprocta cinerascens*), 1 Peacock Pheasant (*Polyplectron chinquis*), 1 Palawan Peacock Pheasant (*Polyplectron napoleonis*), 1 Copper Pheasant (*Syrmaticus soemmerringi*), and 1 Malayan Crestless Fireback (*Acomus erythrophthalmus*) Aviary specimens Gift

Kruger, C E, Laurel Hill, San Francisco 1 Dusky Thrush (*Turdus eunomus*), and 1 Wembere Red Bishop Bird (*Euplectes orix wertheri*) Aviary specimens Gift

Lithuania, University of, Zoological Museum, Kaunas, Lithuania 5 bird skins from Lithuania. Exchange

Maillhard, Joseph, California Academy of Sciences, San Francisco: 3 California Pocket Gophers from Marin County, California Gift

McGettigan, C C, 2644 Filbert Street, San Francisco: 2 Little Brown Cranes (*Megalornis canadensis*) from Kern County, California, and 3 Tule Geese (*Anser albifrons gambelli*) from Colusa County, California Gift

McLaren, John, Golden Gate Park, San Francisco 1 Central California Mole (*Scapanus latimanus latimanus*), 1 Swan, 1 Magpie (*Pica pica hudsonia*); 1 Chukar (*Alectoris græca chukar*), and 1 cygnet (*Olor* sp) Aviary specimens Gift

Meyer, Dr K F, Hooper Foundation, University of California, San Francisco 1 Cotton's Reedbuck (*Redunca redunca cottoni*) Domestic Gift

Moore, C C, 311 Washington Street, San Francisco 1 California Great Blue Heron (*Ardea herodias hyperonca*) from Santa Cruz County, California Gift

Morcom, G Frean, 243 N Coronado Street, Los Angeles, California 92 Hummingbirds from North and South America Gift

Mori Bird Company, 94 Golden Gate Avenue, San Francisco 1 Mikado Pheasant (*Syrmaticus mikado*), and 1 Malayan Crestless Fireback (*Acomus erythrophthalmus*) Aviary specimens Gift

Murphy, Mrs William, 1108 East 14th Street, Alameda, California 8 eggs of Pallas's Murre (*Uria lomvia arra*) from St George Island, Pribilof Group Gift

Peters, D C, 315 Central Avenue, North Palo Alto, California 1 Golden-backed Hanging Parrot (*Loriculus chrysonotus*) Aviary specimen Gift

Pettit, Miss Muriel, Girls' High School, San Francisco 1 Allen's Hummingbird (*Selasphorus alleni*) from San Francisco Gift

Pierce, J H, 1431 Webster Street, Palo Alto, California 1 Yellow Cardinal (*Gubernatrix cristata*) Aviary specimen Gift

Reed, A L, Tulare, California 1 Marsh Hawk (*Circus hudsonius*) Gift

Robison, A W, 1072 Market Street, San Francisco 1 Mealy Rosella (*Platycercus pallidiceps*) Aviary specimen Gift

Rosenberg, W H F, 57 Haverstock Hill, London, England 1 Pheasant (*Phasianus colchicus*), 1 Imperial Parrot (*Amazona imperialis*), and 1 Dusky Lory (*Eos fuscata*) Purchase

Speck, Mrs J., 4217 25th Street, San Francisco 1 Virginia Opossum (*Didelphis virginiana virginiana*) from Mendocino County, California. Gift

Stansfield, J E, Bolinas, California 1 Horned Owl (*Bubo virginianus pacificus*) Gift

Steinbeck, J W, 611 Bristol Avenue, Stockton, California 3 Peacock Pheasants (*Polyplectron chinquis*), 1 Fireback (*Lophura ignita*), 1 Bar-tailed Cuckoo Dove (*Macropygia unchall*), 1 Bronze-winged Pigeon (*Phaps chalcoptera*), 1 Dove (*Leptoptila wellsi*), and 1 Namaqua Dove (*Aena capensis*) Aviary specimens Gift

Sterling, F, 132 Collins Street, San Francisco 1 Grass Parakeet (*Melopsittacus undulatus*) Gift

Swarth, H S, California Academy of Sciences, San Francisco 1 Nuttall Sparrow (*Zonotrichia nuttalli*) from Alameda County, California Gift

Thompson, W W, Middlefield Road, Redwood City, California. 1 Southern Black-tailed Deer (*Odocoileus columbianus scaphiotus*) from Santa Clara County, California Gift

Titus, Miss A B, Jean Parker School, San Francisco 1 Burrowing Owl (*Speotyto cunicularia hypogaea*) Gift

Walther, Eric, Golden Gate Park, San Francisco 1 Nuttall Sparrow (*Zonotrichia nuttalli*) from San Francisco Gift

DEPARTMENT OF PALEONTOLOGY

Anderson, Frank M, and Nicholson, J L, California Academy of Sciences, San Francisco About 50 species of cretaceous fossils from Sacramento Valley, California Exploration

Baker, Fred, Point Loma, San Diego, Calif 7 freshwater shells from Michigan, parts of type lots of two species Gift

Chase, Mr and Mrs E P, San Pedro, Calif 73 marine shells from Crescent City, California, 5 land shells from Los Angeles County, 2 land shells from Pistol River, Oregon, 11 marine shells from various places in Los Angeles County, California, 4 land shells from Santa Ana Mountains, California Gift

Cornwall, Ira, William Head, Box 850, Victoria, B C, Canada 2 lots of barnacles and 1 lot of sponges Gift

Cory, Dr W B, Los Angeles, Calif 1 collection of Vaqueros Miocene fossils from type localities Gift

Field, Stanley C, 1264 Redondo Blvd., Los Angeles, Calif 3 *Micrarionta kellettii* from San Pedro and 5 *Helminthoglypta arrosa* (Semi-albino) from San Mateo Point, California Gift

Frizzell, Don L, Seattle, Washington 4 topotypes of *Paphia restorationensis*, from Puget Sound, Washington Gift

Haley, Dr George, University of San Francisco, San Francisco, Calif 6 specimens of rocks from Bogoslof Island, Bering Sea Gift

Hanna, Dr G Dallas, California Academy of Sciences, San Francisco 150 land shells from near Clear Lake, California, 300 species of marine shells, 150 species of foraminifera, and 12 samples of Miocene diatomite, all from Catalina Island, California Exploration

Hanna, Dr G Dallas, Smith, A G, and Nicholson, J L, California Academy of Sciences, San Francisco 125 species of marine shells dredged in Monterey Bay Exploration

Heath, Dr Harold, Hopkins Marine Station, Pacific Grove, Calif 500 shells dredged from Carmel Bay, California Gift

Hertlein, Dr L G, California Academy of Sciences, San Francisco 3 boxes of cretaceous fossils from Alberta, Canada Gift

Hickox, M E, 1201 Bryant Street, San Francisco 1 box of marine shells Gift

Hubbell, F C, Des Moines, Iowa, through C J Moran, Long Beach, Calif 1 Barnacle, (*Conchoderma virgata*) attached to a Copepod (*Penella filosa*), parasitic on a fish, (*Xiphius gladius*), from sea near Long Beach, California Gift

Israelsky, Merle C, Louisiana Gas and Fuel Company, Houston, Texas 3 pieces of Ostracod shale from Brazil Gift

Johnston, E C, Petaluma, Calif 20 freshwater shells from Clear Lake, Calif Gift

Layer, Herman, Standard Oil Company of Nicaragua, Subway Terminal Building, Los Angeles, California 1 specimen of Turritella from the Tertiary of Nicaragua Gift.

Litsey, J L, Dallas, Texas 2 fossil Echinoids from Florida Gift

O'Shaughnessy, M M, City Engineer, San Francisco, Calif 1 Cretaceous ammonite from Tesla Tunnel, Hetch Hetchy system Gift

Pilsbry, Dr H A., Philadelphia Academy of Natural Sciences, Philadelphia, Pennsylvania. 4 specimens of a land snail from Otero County, New Mexico, 4 land shells from Arizona Gift

Reed, C R, U S S Arctic, San Francisco 2 specimens of Schizaster from Puget Sound, Washington Gift

Slevin, Joseph, California Academy of Sciences, San Francisco 30 land shells from Queensland, Australia Gift

Smith, A G, Berkeley, California 1 Cotype of *Liotia smithi* Gift

Stevens, J B, Fellows, Calif. 29 Temblor Miocene fossils (bivalves and gastropods) Gift

Swarth, H S, California Academy of Sciences, San Francisco 46 freshwater shells from British Columbia Gift.

Van Dyke, Dr E C, University of California, Berkeley, California 1 land shell from Big Sur, California, 1 land shell from Sequoia National Park, California Gift

Williams, Mrs M B, 110 marine and land shells, no localities given, 1 Echinoid (sand dollar), 6 rock specimens (containing pyrite and galena). Gift

FINANCIAL STATEMENTS

REPORT OF THE TREASURER

For the fiscal year ending December 31, 1930

January 1, 1930, Balance due Crocker First National Bank		$ 884 92
Receipts		
Dues	$ 3,946 25	
Charles Crocker Scientific Fund Endowment Income	1,758 75	
James Lick Endowment Income	70,781 07	
General Income	20,893 98	
John W Hendrie Endowment Income	1,646 26	
Post Card Sales	1,167 96	
Publication	630 62	
Interest	1,854 81	
Ignatz Steinhart Trust Interest	286 60	
Bills Receivable	3,000 00	
Duplicate Sales Account	10	
Great Auk Donation	178 55	
W G Wright Fund	10 00	
Park Birds Handbook Fund	1,753 00	
Wild Life Protection Fund	100 00	
Alice Eastwood Donation	568 18	
Total Receipts		$108,576 13
		$107,691 21

REPORT OF THE TREASURER—Continued

Expenditures

Interest	$ 10,766 79	
Contingent Fund	441 03	
Salary Expense General	20,199 31	
Department Salaries	20,864 79	
Earthquake Insurance Sinking Fund	1,200 00	
Bills Receivable	25,000 00	
Steinhart Aquarium Equipment	79 50	
Wild Life Protection Fund	111 25	
Insurance	562 30	
Park Birds Handbook Fund	1,615 06	
Museum Department Appropriations	16,253 12	
Post Card Sales	1,043 69	
Publication	4,369 70	
Library	4,368 02	
Sundry Creditors	872 80	
Expense	3,172 10	
Total Expenditures		$110,919 46
January 1, 1931, Balance due Crocker First National Bank		$ 3,228 25

F W BRADLEY, *Treasurer*

Examined and found correct,

PACE, GORE & MCLAREN, *Certified Public Accountants*
San Francisco, Calif., February 14, 1931

BALANCE SHEET

December 31, 1930

Assets

Property		
Real Estate, 831-833 Market Street	$600,000 00	
Commercial Building, 833 Market Street	516,818 66	
Real Estate, Jessie Street	8,083 65	
		$1,124,902 31
Museum, Golden Gate Park		
Building Construction	192,025 92	
General Collections	216,249 99	
Library and Equipment	157,368 58	
Tools and Equipment	49,434 94	
Office Furniture	6,110 04	
		$ 621,189 47
Investment Securities		$ 7,214 52
Ignatz Steinhart Trust		
Bills Receivable	$ 6,000 00	
Steinhart Aquarium Construction	263,390 29	
Steinhart Aquarium Equipment	34,343 08	
Steinhart Aquarium Revolving Fund	5,000 00	
Uninvested Cash on Hand	178 38	
		$ 308,911 75
Current Assets		
Bills Receivable	$ 79,000 00	
Postcards in Stock	1,850 33	
Cash on hand	161 36	
Advances to employees doing field work	400 00	
		$ 81,411 69
Total		$2,143,629 74

BALANCE SHEET—Continued

Liabilities

Endowments		
James Lick Endowment	$804,902 31	
Charles Crocker Scientific Fund Endowment	20,000 00	
John W Hendrie Endowment	32,770 85	
		$ 857,673 16
Funds Held for Special Purposes		
Alvord Bequest Botanical	$ 5,000 00	
John W Hendrie Endowment Income	2,804 11	
Earthquake Insurance Sinking Fund Reserve	7,114 52	
W G Wright Fund	42 57	
Park Birds Handbook Fund	118 44	
Wild Life Protection Fund	11 10	
		$ 15,090 74
Reserve for Depreciation		$ 165,956 78
Ignatz Steinhart Trust		
Principal	$250,000 00	
Interest	58,911 75	
		$ 308,911 75
Notes and Accounts Payable		
Bills Payable	$195,000 00	
Accounts Payable	2,059 45	
Due Crocker First National Bank (Overdraft)	3,406 63	
		$ 200,466 08
Surplus		$ 595,531 23
Total		$2,143,629 74

Susie M Peers,
Secretary, Board of Trustees

We have examined the foregoing Balance Sheet, together with the books and accounts of the California Academy of Sciences, and in our opinion, it is properly drawn up so as to exhibit a true and correct view of the Academy's affairs, as shown by the books

Pace, Gore & McLaren,
Certified Public Accountants

San Francisco, Calif ,
February 14, 1931

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Page 5	No. 66, for *californica*, read *californicus*
Page 21	No. 192, for *Thias* read *Thais*
Page 21	No. 198, for *sanquinea*, read *sanguinea*
Page 42	Four lines from bottom, for *Nitidiscala*, read *Nitidoscala*
Page 59	Second species in table, for *hemphilli*, read *hemphillii*
Page 59	Ninth species in table, for *latiauritus*, read *latiauratus*
Page 59	Two bottom lines; for *Dentraster*, read *Dendraster*
Page 60	First species under Bryozoa, for *Cauloramphus*, read *Caulorhamphus*
Page 62	Fifteen lines from the top, for *hemphilli*, read *hemphillii*
Page 69	Thirteen lines from top, for *Allodesmis*, read *Allodesmus*
Page 70	Eighteen lines from top, for *Allodesmis*, read *Allodesmus*
Page 105	Lines five and four from bottom, for *praetextatus*, read *praetexatus*
Page 106	No. 3, for *aborea*, read *arborea*
Page 116	Sixteen lines from bottom, for *gigartinoidea*, read *gigartinoides*
Page 117	Nine lines from top, for *Calacodasya*, read *Colacodasya*
Page 356	Six lines from top, for *Oedotus mirus*, read *Oedolithax mira*